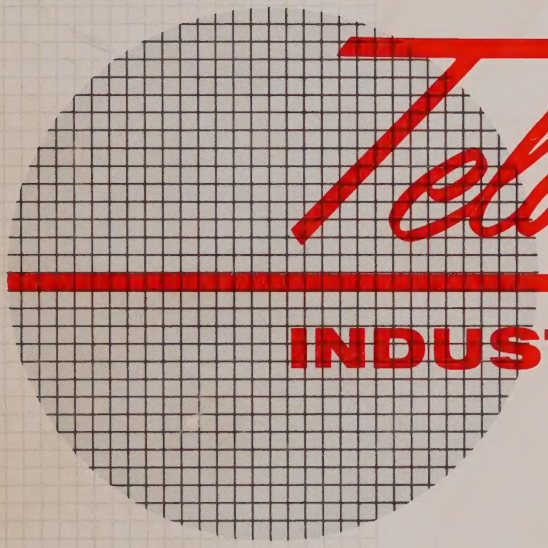
INSTRUCTION MANUAL



Telonic

INDUSTRIES, INC

NOTICE OF PARTS CHANGES

In some units, a 2.0 μf rather than the 2.2 μf capacitor (C402) is used in the lowest rate position of the SWEEP RATE Switch (S401).

MODEL SM-2000
SERIAL NO. 7901
SWEEP/SIGNAL GENERATOR
CONTROL CHASSIS

TELONIC INSTRUMENTS AND ACCESSORIES

Products manufactured by TELONIC INDUSTRIES, INC. are guaranteed against defective materials and workmanship for a period of one year (vacuum tubes and semiconductors excepted) from date of purchase. This warranty does not apply to instruments that have been altered, improperly handled or damaged in any way beyond our control.

Instruments must be examined immediately upon receipt, since claims for damage in transit will not be honored by the carrier unless prompt action is taken.

CHANGES IN SPECIFICATIONS

The right is reserved to change the published specifications of equipment at any time, and to furnish merchandise in accordance with current specifications, without incurring any liability to modify equipment previously sold.

RETURNING EQUIPMENT TO FACTORY

Factory service is available for repair and readjustment of this instrument. However, a description of the trouble should be forwarded FIRST, whereupon instructions for correcting the trouble OR authorization for returning the equipment will be given. This applies to all units, whether under warranty or not.

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SECTION I

SPECIFICATIONS

SPECIFICATIONS

MODES OF OPERATION

*Sweep
The RF output is swept at line frequency with "E" and "S" models. Sweep rate is determined by the SWEEP RATE Switch with "L" models.

*Modulated
The swept RF output is modulated with a 1 Kc square wave.

CW
The RF output is a CW signal.

Modulated CW
The modulation signal is a 1 Kc square wave.

*Note: Zero reference line in these modes results from blanking of the oscillator during return sweep.

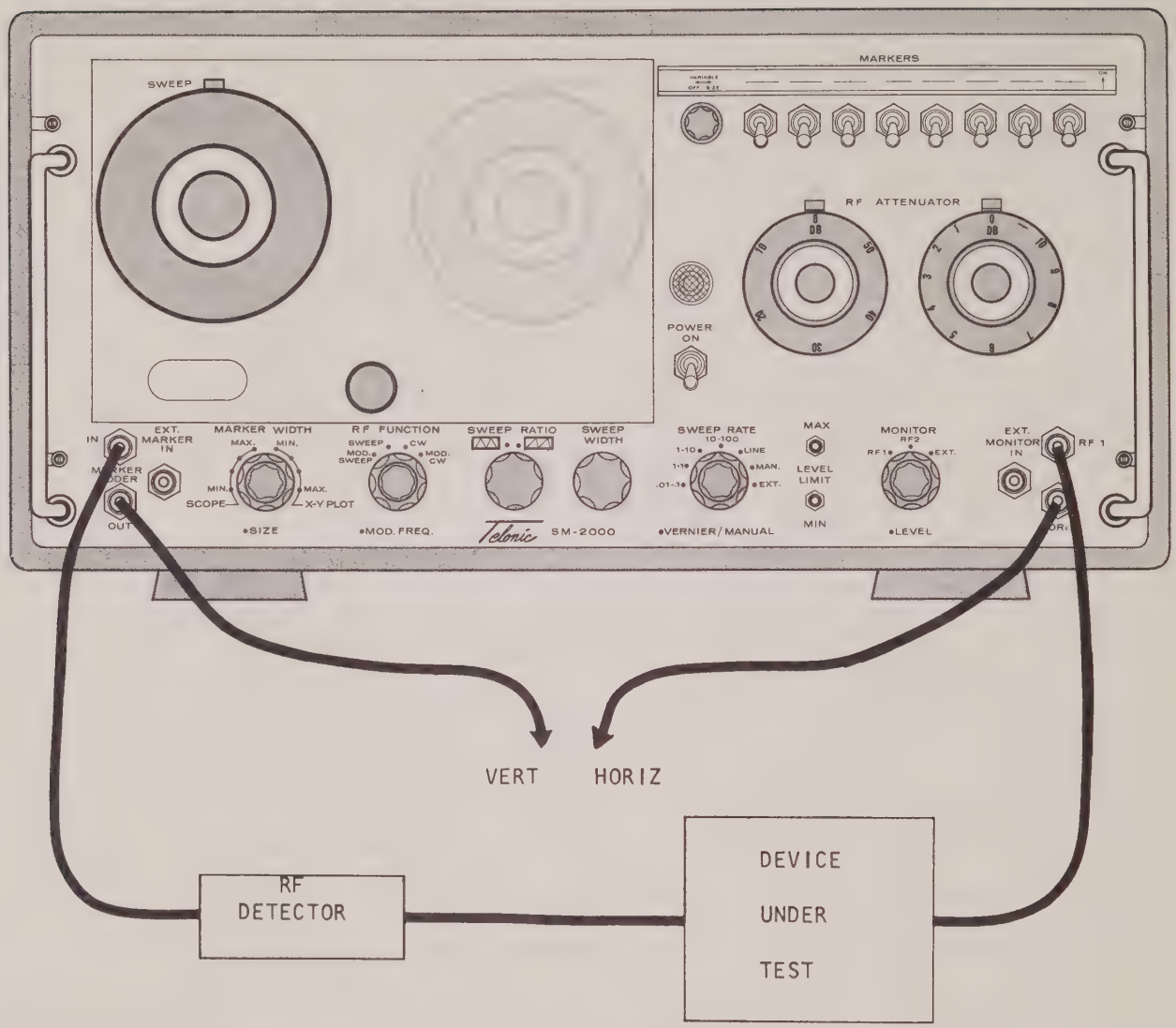
SWEEP RATE	
With "L" type plug-in	
Variable	0.01 to 100 c.p.s.
Line Frequency	50/60 c.p.s.
Manual Drive	Automatic drive switched off and sweep rate controlled manually.
External Drive	Rear panel connection for driving with external signal is provided.
With all other plug-ins	Line frequency (50/60 c.p.s.)
SCOPE HORIZONTAL OUTPUT	Approximately 15V peak to peak Approximately 0V DC average. Triangular or sawtooth waveform with "L" units. Sine wave with all other models.
SWEEP TO RETRACE RATIO	
Variable Sweep Rate ("L" unit only)	1:1 or approximately 10:1 (controlled by Front Panel SWEEP RATIO Switch)
Line Sweep Rate	1:1 only.
OUTPUT	Typically 1 VRMS (depending on oscillator used)
OUTPUT IMPEDANCE	50Ω
FLATNESS	
With RF 1 or RF 2 monitor	Typically ±0.25 db
With External Monitor	Typically ±0.05 db

RF 1 ATTENUATION	0-60 db in 1 db steps Typical accuracy to 900MC, ±3%, or ±0.7 db, whichever is greater.
RF VERNIER LEVEL CONTROL	Typically 0-3 db of range (depends on head).
MARKER SYSTEM	
Birdy-By-Pass Marker Circuitry	The outputs of the marker oscillators are mixed with a signal from the sweep oscillator to produce beatnotes or birdies. These are amplified and superimposed upon the detected RF output signal before it is applied to the vertical scope input. Amplitude and shape of the markers are adjustable over a wide range.
External Marker Input	An external CW signal of approximately 0.1 volts may be used to produce a "birdy" type marker.
Plug-In Crystal Markers	Provisions are included for up to eight single frequency or harmonic type plug-in crystal-controlled markers. These markers are optional and may be included in this instrument or added at a later date. See our literature for further details regarding these markers.
Rectified Markers	For use with X-Y recorders, a marker rectifier is included.
POWER	115 or 230 VAC., 50/60 c.p.s. Approximately 200 watts
PHYSICAL DESCRIPTION	
Panel Size	1/8" x 8 3/4" x 19".
Chassis Size	2" x 14 1/4" x 17".

SECTION II

OPERATING INSTRUCTIONS

TYPICAL SET UP



1. Plug in the RF oscillator for frequency range desired. Never plug in a unit while the power is on. Transient voltages may result in diode damage

2. Make sure that S102 is set for the power line voltage available and plug in.

3. Make connections to the scope (or recorder), the device under test, and RF Detector as shown above. All connectors located on the sweep generator are BNC type and it is recommended that RG cable be used for all connections. This insures good ground connection between each device and minimizes hum, leakage from unit and pickup of spurious external signals. The cable that is used to connect the RF OUTPUT to the device under test should match the impedance of the sweep generator. If the input impedance of the device under test is different from the impedance of the sweep generator, a matching network should be used to insure a constant input signal.

PANEL CONTROLS

FRONT PANEL

POWER (S-101)

In the ON position, this supplies the AC power from the line to the primaries of the SM-2000 power transformer.

RF FUNCTION (S-403)

The mode of operation is selected by this switch.

In the MOD. SWEEP position, both a blanking signal and a 1KC square wave are supplied to V304, the B+ pass tube which controls the operating level of the RF oscillator in the plug-in. A sweep drive is supplied to the wobbulator or variable inductor, resulting in a swept RF output modulated with a 1KC square wave.

In the SWEEP position, the sweep drive and blanking signal are supplied, but the 1KC oscillator is disabled. Blanking during return sweep still occurs.

In the CW position, the SM-2000 is a signal generator. The output is an unmodulated RF voltage.

In the MOD. CW position, the 1KC square wave is coupled to the pass tube, but the sweep drive and blanking circuits are disconnected.

LEVEL (R-304)

This is the manual vernier control of the RF operating level of the plug-in oscillator. This control varies the B+ available to the oscillator tube between the limits imposed by the settings of R303 and R305, the MAX and MIN LEVEL LIMIT Controls respectively (see below).

The LEVEL Control can be used to set the RF output at levels between attenuator steps. It also provides a manual output control when the RF 2 monitor or an external monitor is in use (the turret attenuator is used with the RF 1 monitor only). This control is inoperative with those oscillators which are not leveled by the SM-2000.

LEVEL LIMIT

These controls are set to provide the desired range for the LEVEL Control.

MAX. (R-303)

R303 sets the minimum voltage available at the wiper arm of R304, and hence the maximum average B+ at the pass tube (see discussion under LEVEL above). With the device under test by passed, this control is set for rated generator output, when the LEVEL Control is fully clockwise (maximum setting).

LEVEL LIMIT CONTINUED

MIN (R-305)

R305 sets the maximum voltage available at the wiper arm of R304, hence the minimum average B+ at the pass tube. With the device under test bypassed, this control is set for the desired level below that set with the MAX Control. This can be done as follows:

1. Modify the typical setup to omit the device under test.
2. With the LEVEL and MAX Controls set as above, insert the number of db of fixed attenuation corresponding to the desired range of the LEVEL Control and note the scope deflection.
3. Remove attenuation, set LEVEL Control fully counter-clockwise, and set R305 for the same scope deflection as above.

RF ATTENUATORS

These attenuators are used with the RF 1 output only, and only when an external monitor is not used.

Two turret attenuators in series provide up to 60 db of attenuation in 1 db steps. One unit has a 0-50 db range in 10 db steps and the other 0-10 db in 1 db steps. They are set to provide either the desired level at the output or the desired amount of attenuation, depending on the application. The total attenuation is the sum of the two dial readings.

MONITOR (S-301)(NOTE: This switch is set in the RF 2 position with the LA-1M plug-in oscillator, although the output is taken at the RF 1 jack.)

This switch selects the proper monitor block to provide the input to the automatic level control (ALC) circuit:

RF 1 position: A monitor at the input to the attenuator monitors the RF 1 output only.

RF 2 position: In those units having two outputs, a monitor in the plug-in unit monitors the RF 2 output only.

EXT position: A monitoring circuit is installed at or near the point where the signal is applied to the device under test. This usually provides the best flatness because of the shorter connections from the monitor RF output to the test circuit than is possible with either internal monitor. Either the RF 1 or RF 2 output can be leveled in this manner.

NOTE: The Monitor Switch should always be set to provide leveling of the signal used. Although a protective device is installed to limit the output to a safe level when no monitor is connected, the signal will not be subject to proper ALC action under the following conditions:

Monitor Switch in RF 1 position when RF 2 output is being applied to device under test, or vice versa (except with the LA-1M).
Monitor Switch in EXT position, with either output, but with no external monitor signal provided at J301.

EXT MONITOR IN (J-301)

The DC output (ALC signal) of the external monitor is returned to the ALC circuit through this connector.

RF 1 (J-212)

RF 1 output (any output having a maximum center frequency not greater than 1200Mc) is taken at this point. It may be fed to the device under test directly or through the external monitor.

SWEEP RATE (S-401)

This switch selects the means by which the sweep rate is controlled and, in the variable rate positions, acts as a coarse sweep rate control.

In the LINE position, this switch injects a line (50/60 c.p.s.) synchronized signal to the trigger of the triangular (or sawtooth) waveform generator with "L" oscillators. With other units a 6.3V sine wave is connected to the wobbulator drive in this position.

All other positions of the SWEEP RATE Switch are used with "L" models only.

In the EXT. position, an external voltage connected to the terminal provided on the rear of the chassis supplies the control current for the saturable reactor.

In the MAN. position, the automatic sweep drive is disconnected, and the output is swept manually by use of the VERNIER/MANUAL Control (R439).

In the other four positions of this switch, the coarse sweep rate is selected as indicated. Fine control of the sweep rate is obtained by varying the VERNIER/MANUAL Control.

VERNIER/MANUAL (R421 and R439)

This control is operative with "L" model plug-ins only, and has no effect in the LINE and EXT. positions of the SWEEP RATE Switch.

In the MAN. position of the SWEEP RATE Switch, frequency of the RF output is varied manually at any desired rate by R439.

In the variable rate positions of the SWEEP RATE Switch, R421 provides vernier rate adjustment within the indicated range.

R421 and R439 are ganged to a single front panel control knob, concentric with the SWEEP RATE Switch.

SWEEP RATIO (S-402)

This switch controls the sweep to retrace time ratio for "L" model plug-ins, giving a choice between a triangular or sawtooth sweep. This switch does not alter the sweep rate and has no effect with other than L-type oscillators.

SWEEP WIDTH (R-467 and R-471)

These controls, ganged to a common shaft, vary the sweep drive amplitude and consequently the sweep width of the RF output.

R467 varies the sweep width when the "L" models are used. R471 is used for other units.

HORIZ. (J-402)

A horizontal deflection voltage for use with an oscilloscope, synchronized with the sweep rate, is provided at this connector. The waveform is sinusoidal except with the "L" models, in which a triangular or sawtooth is used.

MOD. FREQ. (R-451)

This is a vernier control of the period of a cycle of the 1KC multivibrator, V405. This control should be set for an oscillation frequency of 1000 cps.

MARKERS (S-501 through S-509)

These switches turn on the variable/external marker and/or individual fixed (crystal plug-in units) markers when in the ON position. The switches are in the B+ line to the marker units. The markers may be applied singly or in whatever combination will identify all frequencies or frequency intervals that are important in a particular application. The VAR/EXT Switch is rotary and is ganged to the SIZE Control for these markers. Toggle switches are used for the fixed markers.

MARKER WIDTH (S-510)

This switch selects one of four standard marker widths in the 15-150KC range. S-510 also selects either an unrectified birdy for oscilloscope presentations or a rectified birdy for X-Y recorders. All markers applied are affected by the setting of this switch. The width selected usually will be the minimum width which will give a firm mark.

SIZE (R-532 and R-533)

These controls vary the marker amplitude of all markers simultaneously. They usually are set for optimum viewing or clearly marked record.

EXT. MARKER IN (J-211)

Any external CW signal being used as a marker is fed in at this connector. Any such signal of approximately 0.1-1.0V amplitude will be found suitable. Marker accuracy will be dependent upon the frequency tolerance of the external source, as untuned amplifiers are employed in the Birdy-By-Pass Marker System of the SM-2000.

MARKER ADDER

IN (J-504)

The demodulated signal from the device being tested is fed into this connector. It is connected through a resistor to the OUT receptacle.

OUT (J-503)

The markers from the Birdy-By-Pass Marker Systems are applied at this point. The markers bypass the device under test to provide better markers without interfering with the response curve. This connector should be coupled to the vertical input of the oscilloscope or to the Y-input of the X-Y recorder.

REAR PANEL

(NOT PICTURED)

FUSE POST	The fuse installed here should be 1.5a delayed action for 230V operation, or 3a delayed action for 115V operation.
EXT DRIVE INPUT	A combination banana jack-binding post connector for external sweep control. Common ground between the SM-2000 and the source of the external sweep drive must also be provided. The external sweep drive signal should be at a 70 v dc reference and have a 100 v peak to peak wave form for proper operation and full sweep width. This connector is used is used with "L" Model plug-ins only.

SECTION III

GENERAL DESCRIPTION

GENERAL DESCRIPTION

The SM-2000 control chassis contains the circuitry which is common to a wide variety of other sweep and signal generators in all frequency ranges, as well as special function circuits not contained in most other instruments; for example,

Power Supply
Monitor and Automatic Level Control Circuit
RF Attenuator
Variable Sweep Rate Circuit
Sweep Drive and Horizontal Output Circuit
Marker Generator and Marker Amplifier
Blanking Circuit
Internal Square Wave Modulation Circuit
All Controls not associated with the particular requirements of the Plug-In Oscillator

The circuitry peculiar to each frequency range and method of sweeping is contained in a separate plug-in oscillator unit. The contacts on each plug-in select the particular outputs of the chassis which are required for that plug-in and switch the controls contained in the oscillator into the proper chassis circuits.

The SM-2000 operates in any one of four modes with all plug-in oscillators:

MODULATED SWEEP
SWEEP
CW
MODULATED CW

The modulation in the two modulated modes is a 1KC square wave which turns the sweep oscillator on and off during alternate half cycles. The 1KC square wave is generated in a special circuit on the chassis.

There are three general types of plug-ins. They are distinguished by a model number in which the first letter designates the method of sweeping.

"L" Models with a saturable reactor sweep.
"S" Models with a wobbulator sweep which varies capacitance, inductance, or both.
"E" Models, similar to "S" Models except that an additional (RF 2) output at a harmonic frequency is generated. This output is available on the front panel of the plug-in, rather than on the SM-2000.

Other letters used in the model number have the following significance:

"A" - Audio and low video frequencies
"B" - Band switching model
"H" - Heterodyne output
"M" - Variable marker included in plug-in

With the "L" Models only, a choice of four sweep techniques is available.

Variable rate from 0.01 to 100 cps with vernier control
Line (50/60 cps) synchronized sweep
External sweep drive
Manual sweep

Also a choice of 1:1 or 10:1 sweep to retrace ratio is provided with the variable sweep rate. A scope horizontal output derived from the sweep drive is provided in each case.

In all other plug-ins, the sweep is driven by a sinusoidal voltage from the power transformer, and the horizontal output voltage is also a phased sine wave at line frequency.

POWER SUPPLY

The power supply furnishes the following voltages:

Two regulated positive voltages (175V and 100V)
One unregulated positive voltage (approximately 350V)
Two regulated negative voltages (87V and 150V)
Two oppositely phased 6.3V filament voltages with grounded reference
One isolated 6.3V filament supply operating at +100V DC

The power supply employs two half-wave silicon rectifier systems, one developing the positive voltages and the other the negative voltages.

The rectifier system having a positive output furnishes about +350V to two electronic regulator pass tubes, V105 and V104. The output voltage of V105 (+175V) is sampled. Any deviation from normal is amplified and, through phase reversal in V103A, counteracts the deviation by altering the grid voltage of V105. The 100V output of V104 is regulated similarly by V103B. The negative rectifier system output voltages are filtered and then stabilized to -150V and -87V by V101 and V102 respectively. These are voltage regulator tubes, having resistances which decrease when applied voltages increase and vice versa. Hence tube current increases when the voltage across the tube tends to increase, and decreases when the voltage decreases. This causes the voltage drops across R124, R125 and R126 to increase or decrease in step with variations in source voltage, holding the voltage drop across the voltage regulator tubes essentially constant.

Also, variations in load current will be compensated by an opposite variation in regulator tube current. This follows from the fact that load current changes tend to change the voltage drop across R125, R125 and R126, initiating the action described above.

The -87V is a stabilized power supply reference voltage only and is not a power source for any other component of the instrument. This is an extremely stable voltage because the input to the resistor in series with V102 is regulated at -150V by V101.

AUTOMATIC LEVEL CONTROL CIRCUITRY (NOTE: This circuit is inoperative with some units. The monitor is bypassed in these units, and leveling is accomplished by adjustments in the plug-in oscillator.) A constant output level is desirable for most applications. To provide this, an RF monitor (diode detector) produces a DC voltage proportional to the RF output signal. This voltage is used to control the ALC circuit by decreasing the B+ applied to the sweep oscillator when the output rises above a certain preset limit.

In the SM-2000, a choice of two (or three) monitoring points is provided:

At the input to the turret attenuator
At the RF 2 output on plug-ins having two outputs
(See manual for the particular plug-in for discussion.)
In an external monitor circuit which is optional equipment

AUTOMATIC LEVEL CONTROL CIRCUITRY CONTINUED

When the MONITOR Switch is in the RF 1 position, the RF 1 output is monitored by a diode detector at the attenuator input. This detector furnishes a DC voltage, proportional to the RF 1 output level, to the automatic level control circuit. This provides a leveled RF 1 signal.

In the EXT position of the MONITOR Switch, the input to the ALC circuit is furnished by an external monitor circuit (RF 1 or RF 2 output may be used).

Certain plug-ins have a built-in monitor, and setting the MONITOR Switch in the RF 2 position utilizes this monitor to control the ALC circuit, resulting in a leveled RF 2 output.

RATE GENERATOR

To produce the sawtooth or triangular voltages required for sweep drive and scope horizontal output with "L" models, a square wave generator is coupled to a Miller Integrator in a feedback loop. The same circuit also provides a blanking signal.

SCHMITT TRIGGER

The Schmitt Trigger square wave generator (V401B,C) is a voltage controlled switch which produces a square wave output if its input voltage varies over a sufficient range to switch it from grid clamp to cut off and back again. Because of the way it is biased, the Schmitt Trigger exhibits hysteresis. That is, the voltage required to switch from cut off to clamp is more positive (by about 12V) than the voltage required to switch from clamp to cut off.

MILLER INTEGRATOR (V403)

The integrator works on the principle that a step voltage applied to the grid of the tube tends to create a large step of opposite polarity at the plate. This is coupled back to the grid through a capacitor and limits the input signal to a constant rate of rise and fall due to the changing current flowing through the series grid resistor. Thus, a linear ramp voltage is produced at the output of the integrator. The slope (volts/second) of the triangular or ramp voltage is proportional to square wave amplitude and inversely proportional to the RC product in the integrator grid circuit so that the time required for each side of the ramp to traverse the hysteresis spread of the Schmitt Trigger is controlled in two ways:

1. By changing square wave amplitude
2. By changing the RC time constant in the integrator circuit.

Changing the positive and negative square wave amplitude provides 10:1 or 1:1 sweep to retrace ratio. Range switching is affected by switching integrator capacitors to change RC. The square wave amplitude is controlled by two clipping diodes.

BLANKING CIRCUIT

The purpose of the blanking circuit is to produce a zero base line in the SWEEP and MOD SWEEP modes by removing B+ from the sweep oscillator during the sweep retrace.

With the "L" type plug-ins, the blanking voltage is the square wave produced in the rate generator. This square wave is fed to the blanking switch tube which turns the B+ pass tube off and on during alternate half-cycles. This procedure allows B+ to reach the sweep oscillator during forward sweep only. The sweep oscillator conducts during the negative half cycle of the Schmitt Trigger output waveform.

Action is different in the "E" and "S" units. The sweep drive is a sine wave voltage from the power transformer. A properly phased 60 cps square wave is required for the blanking operation. This blanking voltage is originated by squaring and amplifying a phased 6.3 volt sine wave. This square wave controls the sweep oscillator voltage regulator tube, and thus deprives the sweep oscillator of plate voltage during one-half of each cycle. PHASE and WIDTH Controls are provided for adjusting this blanking voltage to coincide with the horizontal and sweep drive signals.

The blanking circuit is operative in the SWEEP and MOD SWEEP positions of the RF FUNCTION Switch only.

1KC MODULATION

The 1KC square wave with which the RF output is plate-modulated in the MOD SWEEP and MOD CW modes is generated by a plate to grid coupled astable multivibrator, with the screen grid of a pentode acting as one plate of the multivibrator. The output is electron coupled to the pass tube from the plate of the pentode. Since this plate conducts or is cut off, depending upon the voltage at the control grid of the pentode, the plate circuit serves as an electronic switch to connect the control grid of the pass tube to B- during the interval when the pentode conducts.

SWEEP DRIVE

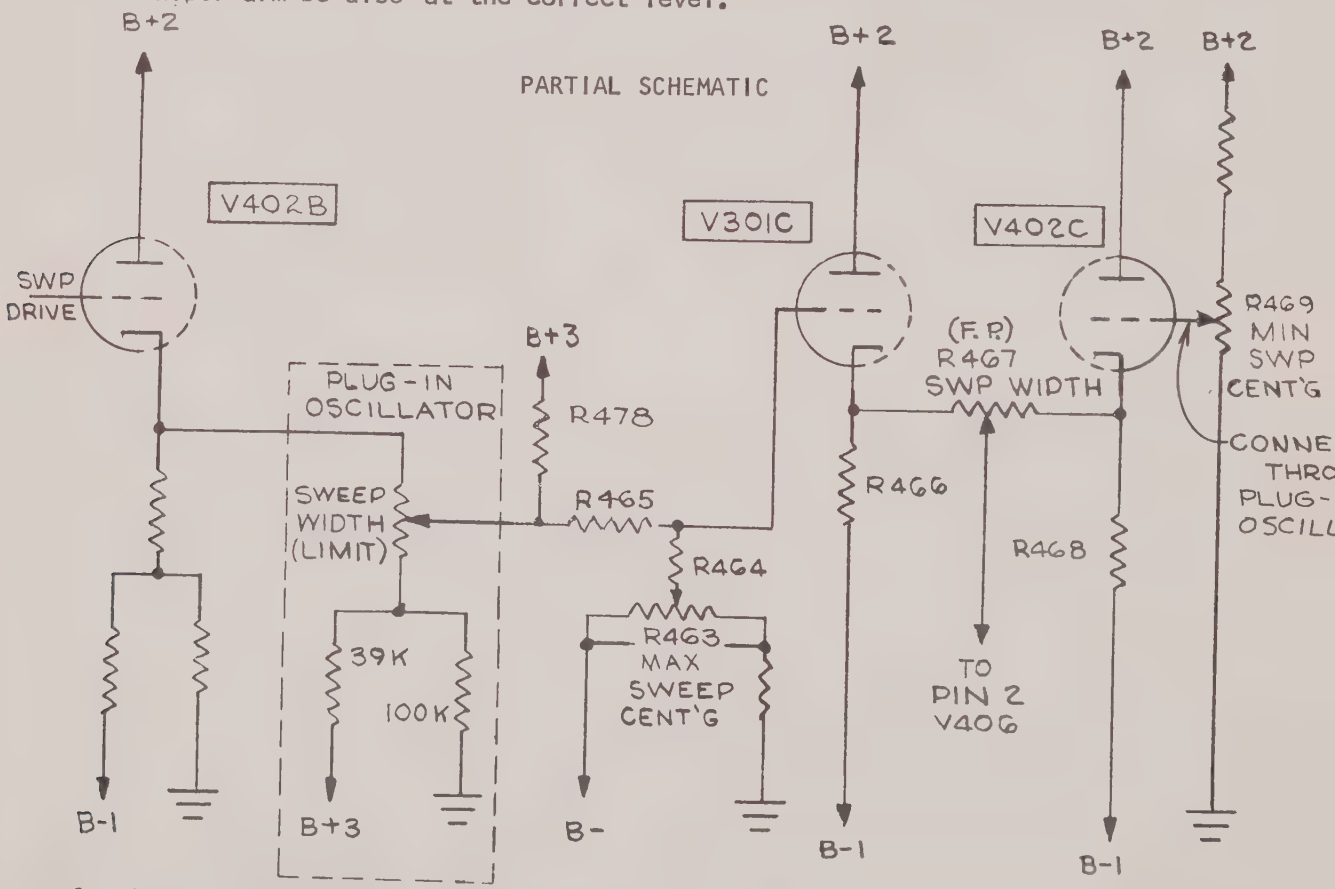
"L" MODELS: With the "L" models, which use a saturable reactor as a sweep device, the sweep drive is controlled by the output of the rate circuit Miller Integrator.

The triangular or sawtooth output of the integrator is coupled through the sweep width limit control in the plug-in and the front panel SWEEP WIDTH Control to the grid of the reactor drive tube. Since the control winding of the saturable reactor is in the plate circuit of this tube, the instantaneous voltage at the grid determines the current through the control winding.

SWEEP DRIVE CONTINUED

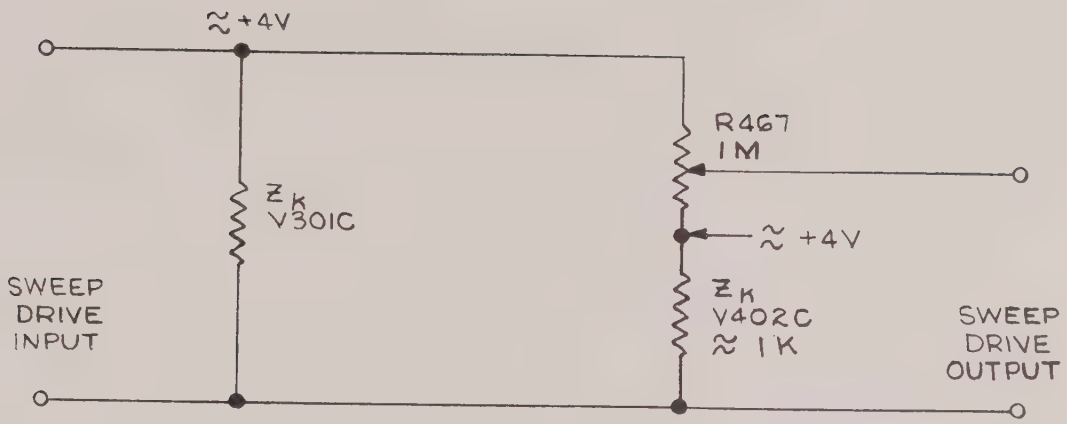
The CENTERING Controls at MAXIMUM and MINIMUM sweep width, when properly adjusted, maintain the proper dc potential at all points of the ac voltage divider consisting of the sweep width limit control in the plug-in, R465, and R467 (SM-2000 SWE WIDTH Control). The cathode of V402C is at effective AC ground to the drive signal because of the low impedance of the cathode circuit.

The reactor drive current is determined by the grid voltage of V406, which is the potential at the wiper arm of the SWEEP WIDTH Control. In order that the center value of the current will remain the proper value as the SWEEP WIDTH Control is varied, it is necessary that the center value (DC value) of the voltage at the wiper arm be also at the correct level.



Referring to the partial schematic above, it is seen that the voltage at the left end of R467 is that at the cathode of V301C and thus is determined by the voltage at the grid. The dc value of this voltage is determined by the setting of R463 and the amplitude of the drive waveform at the same point by the strength of the signal coupled to the grid from the plug-in oscillator unit.

The dc voltage at the right end of R467 is similarly determined by the setting of R469. The drive signal at this point is near zero because of the very low impedance of the cathode circuit of V402C. This effect is obvious when the cathode impedance of V301C, R467, and the cathode impedance of V402C are represented as a voltage divider for the sweep drive. See diagram on following page, in which the sweep drive signal can be varied over a ratio in the order of 500 to 1.



As outlined in CALIBRATION PROCEDURE, Section IV, the dc voltages at the cathodes of V301C and V402C, and hence at both ends of R467, are equalized by proper adjustment of R463 and R469. Thus varying R467 supplies a <u>varying</u> drive voltage, at a <u>constant</u> dc level, to the grid of V406.

The low cathode circuit impedances of V301C and V402B prevent interaction between the the MAX and MIN centering controls.

SWEEP DRIVE CONTINUED

E AND S MODELS: With other than "L" models, the sweep drive to the wobbulator is derived from a 6.3V filament winding of the power transformer. This voltage is divided across a fixed and a variable (sweep width limit control) resistor in the plug-in and R471, the other front panel SWEEP WIDTH Control Potentiometer. Since the voltage at the wiper arm of R471 is applied directly to the wobbulator motor, its amplitude determines the strength of the drive signal.

TURRET ATTENUATOR

The turret attenuator used in the SM-2000 consists of two units. One unit provides 0-10 db of attenuation in 1 db steps. The other is a 0-50 db section with 10 db steps. Thus every 1 db step in the 0-60 db range can be set.

BIRDY-BY-PASS SYSTEM (NOTE: This system is inoperative when the plug-in contains its own fixed marker circuitry.

Frequently the Birdy-By-Pass System is confused with crude marker systems in which the marker is produced by non-linear mixing in the unit under test. In such systems, a CW RF source (called the marker) and whatever sweep signal happens to be within the pass band of the device under test heterodyne to produce a (video frequency) birdy which suffers from these and other defects.

A. No birdy appears if either the CW source or sweep signal gets lost in detuned circuits.
B. Overloading of the device under test by the strong CW source occurs easily.
C. No shaper (width) or size (amplitude) control is provided.

To understand the birdy-by-pass system, these points must be considered:

A. How a marker is produced.
B. What a marker looks like on the scope.
C. How a marker is connected in a typical set-up.

To produce a birdy type marker, two inputs are needed:

1. Sweep frequency signal (sweep sample)
2. CW frequency signal (crystal oscillator or variable oscillator)

A. These inputs are mixed in individual marker units which provide a heterodyne output (birdy) when the sweeping signal passes through the frequency of the CW oscillator.

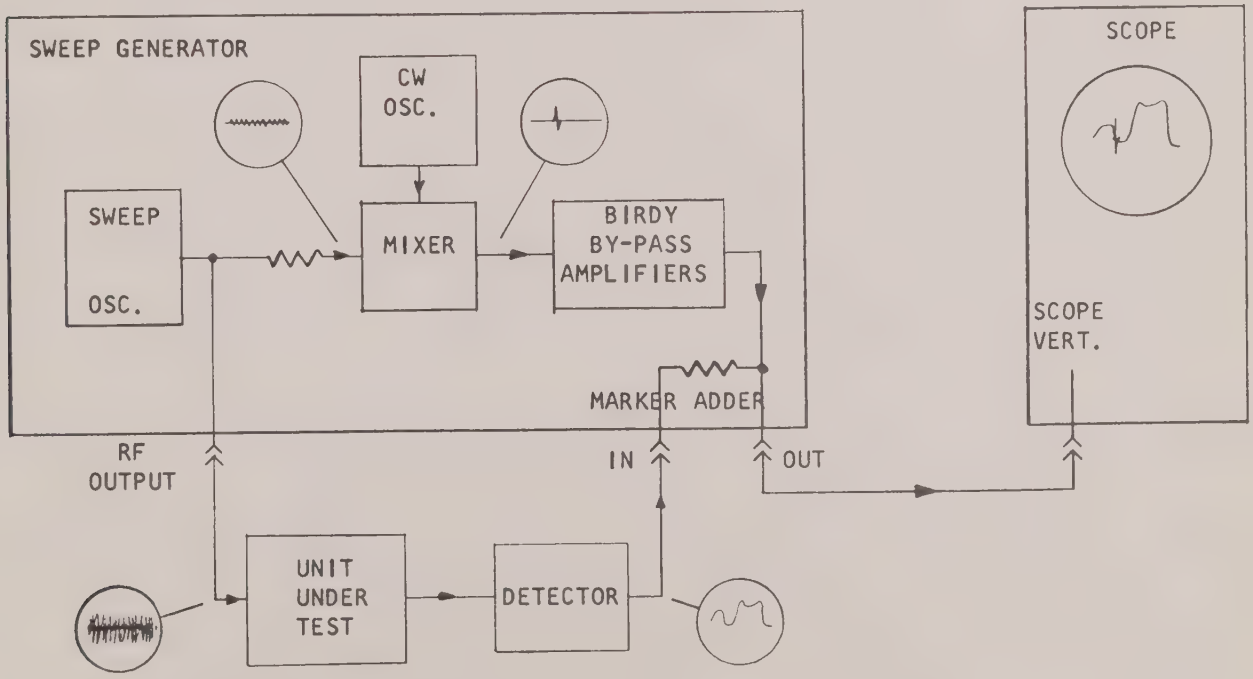
In the birdy-by-pass system of the SM-2000, the plug-in marker units

BIRDY-BY-PASS SYSTEM CONTINUED

are operated singly or in any combination by individual toggle switches on the front panel and are coupled through separate size (amplitude) controls. S509 turns on the variable marker unit, and its output, together with any external marker used, is fed directly from the marker mixer in the SM-2000 to the wiper arm of the EXT/VAR SIZE Control, ganged to S509. The markers are amplified, shaped, and amplified again, after which the size of all markers is adjusted by a front panel control. The markers are next coupled to the output jack of the MARKER ADDER section and superimposed on the demodulated RF response signal of the device under test. See the diagram below. If the Marker Width Switch is in an XY-Plot position, the markers are rectified prior to being applied to the response signal.

NOTE: In some plug-in oscillators, the variable marker oscillator output is mixed with the sweep sample in the plug-in rather than in the SM-2000. The resulting birdy is fed directly to the birdy-by-pass amplifier system instead of through the SM-2000 marker mixer in such units.

B. The birdy marker will appear as a narrow vertical line at wide sweep widths, but as sweep width is reduced the birdy is spread out with an amplitude peak on each side of the zero beat. This birdy shape is a video envelope which represents the band-pass response of the birdy amplifier used.



EXTERNAL MARKER INPUT

The CW signal from the external marker input is fed into a diode mixer and mixed with a sample of the sweep signal to produce a birdy which is then fed into the birdy-by-pass amplifier through R511.

GENERAL DESCRIPTION OF PLUG-IN MARKER BOXES

A plug-in marker box contains a sweep sample input and output, an oscillator, a mixer, and a birdy output connection (at the plug-in base). The CW oscillator signal is self contained and crystal controlled. The sweep sample input is introduced at a BNC Connector (from the sweep oscillator) and leaves through a short piece of coaxial cable to enter another plug-in marker box or to be terminated through a 50Ω resistor to ground. For fuller information than that presented here, see the manuals for the individual marker units installed. Plug-in markers are not used with plug-in units having self-contained fixed marker circuitry.

MIXER CIRCUITS USED IN PLUG-IN MARKERS

The mixer circuit used in single-frequency marker units consists of a diode mixer with an input circuit tuned to the frequency of the desired marker. This circuit rejects all sweep frequencies except the desired marker frequency. This tuned circuit is omitted in the HARMONIC TYPE plug-in marker boxes, since markers at many sweep frequencies are desired.

OSCILLATOR CIRCUITS USED IN PLUG-IN MARKERS

Because of the wide range of frequencies at which markers are needed, a single type oscillator circuit is not suitable. The two basic types used are:

#1 PIERCE OSCILLATOR CIRCUIT 0-12.5 MC

A. Uses parallel crystal
B. Requires no tuning adjustment

#2 OVERTONE OSCILLATOR CIRCUIT ABOVE 12.5 MC

A. Uses series crystal
B. Requires tuning adjustment

NOTE: This circuit oscillates at a fundamental frequency determined by a high order mode of the crystal. Tuning selects the proper crystal mode.

At frequencies higher than about 60 MC, harmonics of the fundamental oscillator frequency are used, and often a tuned circuit adjustment is provided to select one of these harmonics.

PLUG-IN MARKER TYPES

C Single Frequency Type
CH Harmonic Type
CDH Extended Harmonic Type

The SM-2000 has provisions for a maximum of eight single frequency (C Type) crystal markers, eight harmonic (CH Type) crystal markers, four harmonic (CDH Type), or any combination. Each CDH type marker occupies the same space as two C or CH units.

TYPE C

These markers provide a single marker at a selected frequency. There may be variations in circuitry, for two reasons.

1. Wide frequency range over which markers are needed.
2. Need for narrow birdies at low frequencies.

By tuning the sweep sample coupling circuit, the sweep frequency which enters the diode mixer circuit can be varied, thus minimizing the unwanted markers generated from other harmonics of the crystal oscillator. The amplitude of the birdy can be varied by adjusting the sweep coupling loop position.

HARMONIC TYPE CH AND CDH

These provide birdy markers at evenly spaced frequency intervals at harmonics of the oscillator frequency used. The CDH type covers a very broad range but requires space for two C or CH type markers. High order harmonics of the oscillator frequency are generated in a one or two-diode mixer circuit.

INSTALLATION OF PLUG-IN MARKERS

These plug-in units can be inserted in any one (or two) of the eight plug-in sockets, built-in on all Telonic Sweep Generators, that will provide a connection for the sweep sample input and output connections. The sweep sample input (BNC jack) can be fed from either one of the two sweep sample lines in the unit or from the sweep sample output of an adjacent plug-in unit. The sweep sample output (BNC plug) should be connected to either one of the two BNC terminators on the chassis or the sweep sample input of an adjacent box, to provide a 50 ohm matched termination.

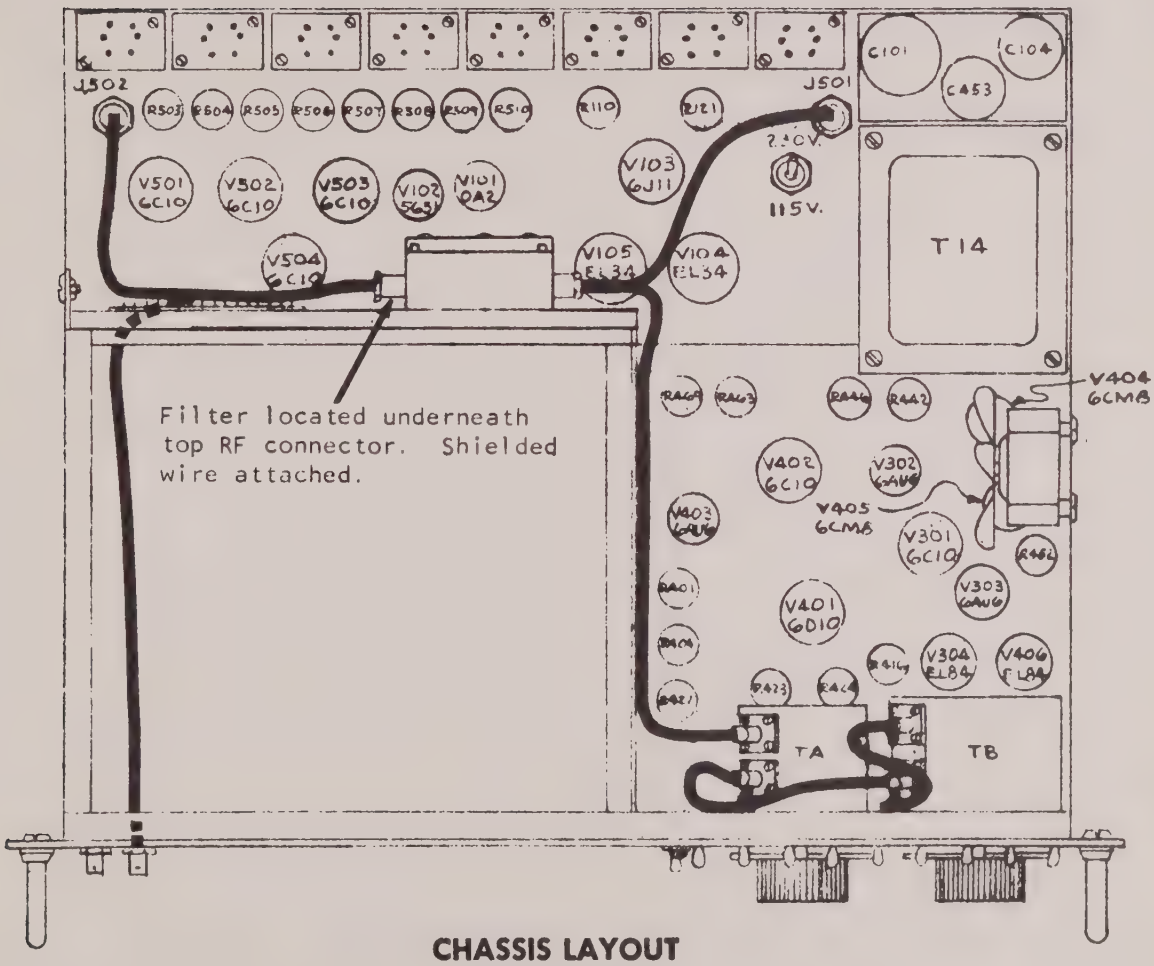
Correct operating voltages are supplied to the sockets from the SM-2000 chassis.

VARIABLE MARKERS

Variable markers, if supplied, are contained in the plug-in units and are discussed in the manuals for the individual oscillators.

SECTION IV

CALIBRATION PROCEDURE



CHASSIS LAYOUT
Top View

GENERAL

1. Connect the SM-2000 to proper line voltage. See description of S102 below. Make the setup shown on page 2-1, omitting the Device Under Test.

2. All connectors located on the sweep generator are BNC type and it is recommended that RG cable be used for all connections. This insures good ground connection between each device and minimizes hum, leakage from unit and pickup of spurious external signals. The cable that is used to connect the RF OUTPUT to the detector, meter, or scope should match the impedance of the sweep generator.

3. Turn the power ON and check to see that V101 and V102 are both fired. If not, see MAINTENANCE, Section V.

4. Do not plug in an oscillator at this time.

   NOTE: A plug-in test fixture is manufactured by Telonic specifically for use in calibrating the SM-2000 Control Chassis. Calibration using this unit should follow the manual for the test fixture instead of the procedure outlined here.

CHASSIS CONTROLS

POWER SUPPLY

The outputs of the power supply in the SM-2000 are regulated at the nominal values by electronic regulator tubes V103A and B. The grid bias voltages on these tubes are set by R110 and R121 respectively. These bias voltages determine the plate voltages. Since the plates of V103A and B are DC coupled to the control grids of V105 and V104 respectively, the biases on the latter tubes are dependent on the plate voltages of the former. The cathode follower action of V105 and V104 causes B+2 and B+3 to be dependent on the grid voltage of the same tubes. Thus the settings of R121 and R110, through the above actions, determine the B+ voltages.

SUPPLY VOLTAGE ADJUSTMENTS

S102: This switch connects the primaries of the power transformer in parallel aiding for 115V operation and in series aiding for 230V operation. It must be set to the position corresponding to the line voltage available.

NEGATIVE VOLTAGES

Although there is no adjustment for these voltages, they must be at the proper level before the positive voltages can be stabilized at their proper respective values.

Connect a VTVM or 20,000 ohm per volt voltmeter between J601-13 (B-2) and ground. Reading should be approvimately -87V. Read the voltage between J601-12 (B-1) and ground. This should be about -150V. If either voltage is outside the specified operating range of the corresponding regulator tube, see Section V, MAINTENANCE.

B+2 (R110)

Connect the voltmeter between J601-4 and ground. Adjust R110 for a reading of +175V.

B+3 (R121)

Connect the voltmeter between J601-5 and ground. Adjust R121 for a reading of +100V.

VARIABLE RATE CIRCUIT

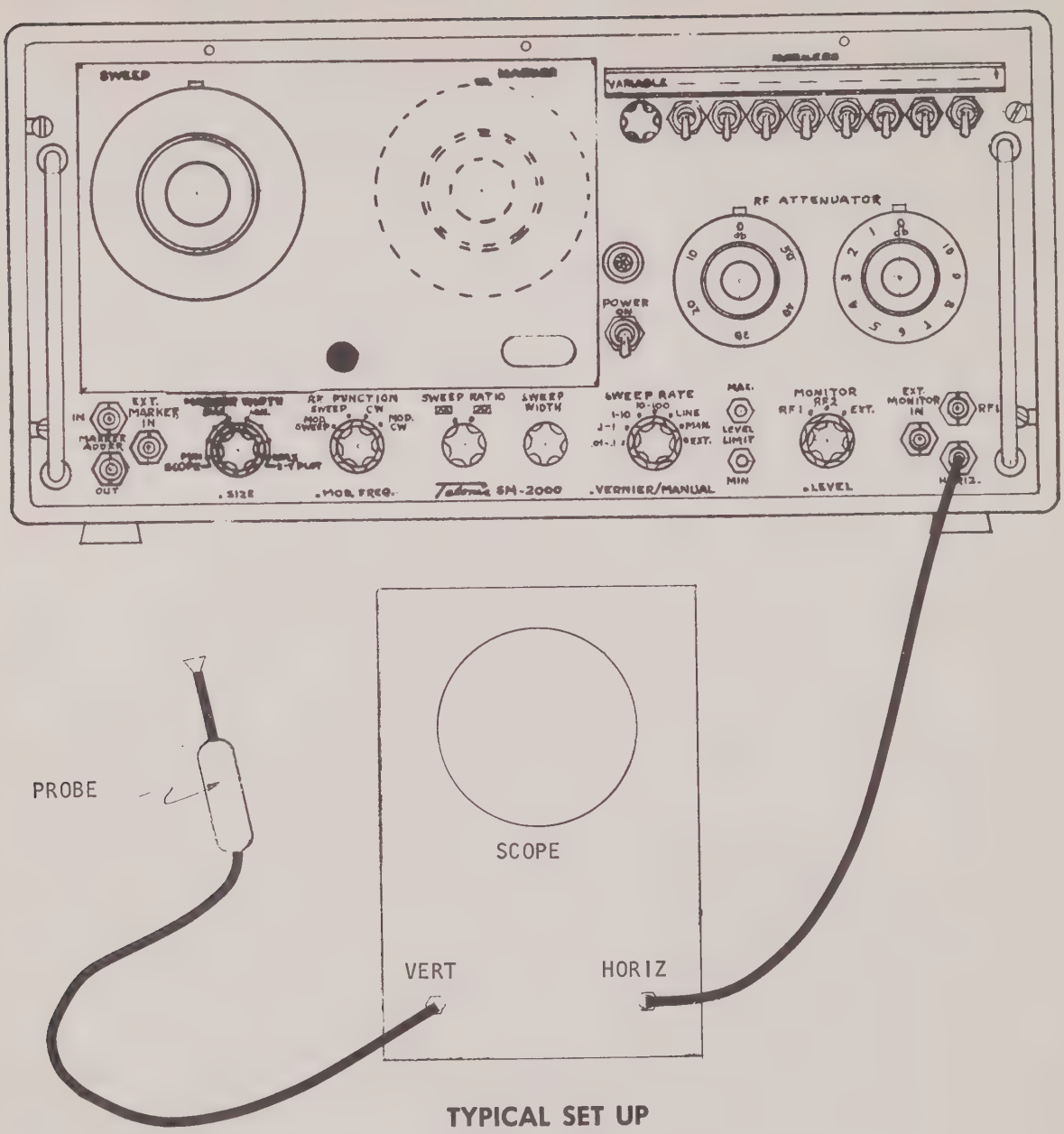
The seven controls in the variable rate circuit determine both the presence or absence and the character of the reactor driving waveform for L-type plug-ins.

R401 determines the amplitude of the feedback to the Schmitt Trigger circuit.

R404 sets the bias on V401B. These two controls are adjusted for stable oscillation of the trigger.

R416 sets the positive voltage at which CR401 clips the square wave output of V401C. This potential is DC coupled to the Miller Integrator and thus determines the period of the negative-going portion of the triangular (or sawtooth) waveform from that stage. In the position of the SWEEP RATIO Switch, R423 similarly sets the negative voltage at which CR402 clips the same waveform. In the position of the SWEEP RATIO Switch, this clipping voltage is set by R424. Thus the period of the positive-going portion of the Miller Integrator output waveform is determined by the setting of R429 in the position and by R430 in the position, whichever of these two controls is in the circuit. The period, then, of the entire waveform is set by R416 and either R423 or R424. In the position of the SWEEP RATIO Switch, values of capacitance used in the plate-to-grid feedback circuit of the Miller Integrator are about 1/5 those used in the position, reducing the period of the negative-going portion to approximately 1/5 of the value set by R416 in that position. The frequency of the waveform in the position is returned to its correct value by adjusting R424 to obtain a period equal to that set by R416 and R423 in the position. This gives an approximate 10:1 sweep to retrace ratio in the position.

R422 is a vernier adjustment of the RC time in the plate-to-ground circuit of the Miller Integrator. The setting of this control determines how much the plate voltage of V403 can change during either half-cycle of the square wave, and hence the amplitude of the Miller Integrator output. This control is in the circuit with the SWEEP RATE Switch in LINE position.



TYPICAL SET UP

VARIABLE RATE CIRCUIT ADJUSTMENTS

GENERAL

The following calibration procedure should be conducted with a high-quality DC oscilloscope using a compensated 10:1 probe with input impedance of at least 10 megohms and is written for a scope with a full scale of 10 cm.

Ground the oscilloscope to the SM-2000. A convenient means of grounding is by connecting the HORIZONTAL OUTPUT Jack of the SM-2000 to the HORIZONTAL INPUT Connector on the oscilloscope.

Set the scope controls for a free-running 20 millisecond sweep with internal trigger and at 20 volts full scale vertical deflection (with a 10:1 probe, this represents 20V/cm).

Plug in an oscillator in the L,LA,LB, or LH series. If none of these units are used, this circuit is inoperative and needs no calibration.

Preset the following front panel controls as indicated:

SWEEP RATE to LINE position
SWEEP RATIO to
RF FUNCTION to SWEEP
SWEEP WIDTH to minimum (fully counter-clockwise)

Preadjust the following printed circuit board controls as indicated:

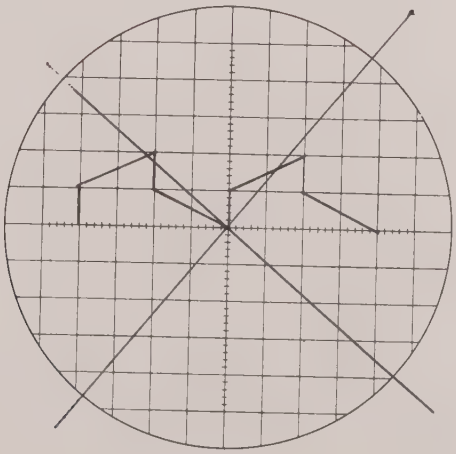
SWEEP PERIOD (R423) fully counter-clockwise as viewed from top
RETR (R416) fully counter-clockwise as viewed from top
LINE SIZE (R422) and TRIG AMPL (R401) to mid-range

PRELIMINARY ADJUSTMENT

Connect the vertical scope input to Pin 7 of V401B and adjust R404 for approximately -60V. If the rate circuit is oscillating properly, a complex waveform, about 20V peak to peak, will be present. If a DC voltage instead is present, adjust R401 and R422 until a waveform appears. Since these two controls interact, several trial adjustments of each may be necessary before oscillation commences.

Connect the probe to Pin 6 of V402.

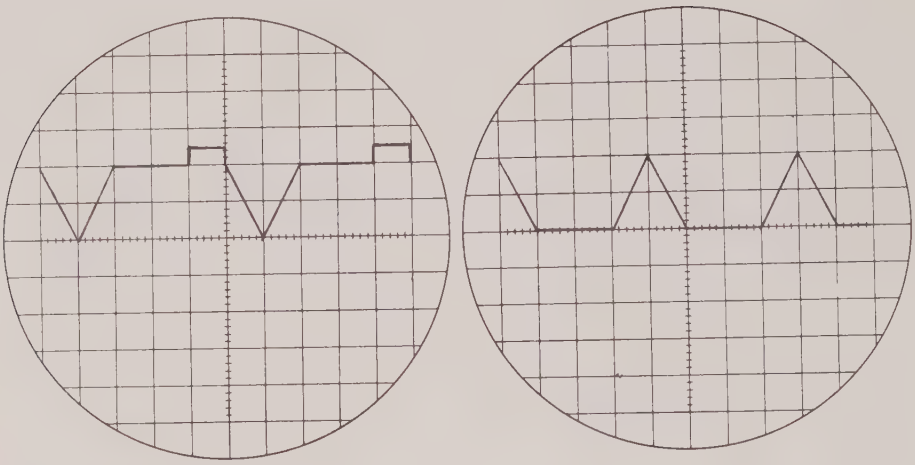
Turn the SWEEP RATE Selector Switch to 10-100 position. A triangular waveform ~~similar to the following~~ will appear if the rate circuit is oscillating.



If not, switch back to LINE and adjust R401 and R422 until the waveform is seen upon switching to 10-100 position.

When oscillation in this position is assured, reset the SWEEP RATE Switch to the LINE position.

If either of the following waveforms appears, readjust R401, R404 and R422. for a triangular waveform.



When a triangular waveform is present, continue with the calibration procedure.

TRIG BIAS (R404)

With the scope still connected to Pin 6, V402B, adjust R404 for a DC level of +70V.

TRIG AMPL (R401) and LINE SIZE (R422)

Leave the scope connected as above. Adjust R401 and R422 for a triangular waveform of 100V peak to peak amplitude.

Reset R404 for +70V DC level if necessary.

Leaving the oscilloscope connected as above, switch the SWEEP RATE Switch to 10-100 position and set the VERNIER/MANUAL Control fully clockwise (highest sweep rate). Readjust R401 (and/or R404) for a 100V peak to peak waveform at a DC level of +70V.

> NOTE: Oscillation may cease upon switching to this position, but proper adjustment of these two controls normally will restore proper functioning.

Switch back to LINE position and readjust R422 for a 100V peak to peak waveform.

RETR (R416) and SWEEP PERIOD (R423)

Change SWEEP RATE setting to 10:100 position.

Connect the vertical input of the oscilloscope to Pin 3 of V402A.

If the adjustments prescribed have been made properly, a rectangular waveform of approximately 100V peak to peak amplitude should be seen.

Adjust R416 for 5 millisecond duration of the positive portion of the waveform.

Adjust R423 for 5 millisecond duration of the negative portion.

This results in a square wave of approximately 80V peak to peak amplitude at a DC level of zero.

Reconnect the scope to Pin 6 of V402B. The triangular waveform should still be of the proper amplitude, period, and level as previously set. If the DC level is incorrect, readjust R404 for +70V DC. Period and amplitude should now be correct. If not, readjust R401 for 100V peak to peak amplitude and repeat the above procedure with R416 and R423 for proper adjustment of period.

SAW SWP RATIO (R424)

Set the SWP RATIO Switch in the position. A sawtooth waveform should appear. Adjust R424 for a total period of 10 milliseconds.

This concludes the adjustment procedure for the rate generator circuitry.

REACTOR DRIVE

As the front panel SWEEP WIDTH Control (R467) is varied between maximum and minimum sweep widths, it is necessary that the DC potential at the wiper arm remain constant. This is accomplished by the settings of R463 and R469. The action of these controls, including a partial schematic diagram, is presented in Section III.

CURRENT CENTERING

Centering current controls are adjusted with a "dummy" plug inserted in J601. To construct the plug, proceed as follows:

1. Obtain a 32-contact Amphenol plug type 26-4100-32P (Telonic Part Number S-39).
2. Jumper Pin 14 to Pin 15 and Pin 19 to Pin 20.
3. Solder heavy wire leads about 1" long to Pins 4 and 30, making a circular loop at the end of each.

   NOTE: A properly wired plug may be ordered from Telonic Industries, Inc.

With SM-2000 power OFF, insert the dummy plug and connect an ammeter between the two leads soldered to Pins 4 and 30. To proect V406, make sure the ammeter remains connected at any time the power is ON.

Preset the following controls:

SWEEP WIDTH for minimum sweep width

R121 for exactly 100v, using most accurate standard available. Components of the circuit are chosen to perform optimally under this condition.

Connect a vacuum tube voltmeter or 20KΩ/v voltmeter across R473. Set the voltmeter on the 10v range and adjust CENT. MIN. SWEEP (R469) for a reading of 8.46 volts. Set the Front Panel SWEEP WIDTH Control for maximum sweep width. Adjust the CENT. MAX. SWEEP, R463, for a meter reading of 9.4 volts.

MODULATION CIRCUIT

The frequency of the 1KC square wave with which the output is modulated in the MOD SWEEP and MOD CW modes is determined by the RC time of the coupling capacitors in series with R451 and R452. R452 is a coarse frequency control, which is set in such a position as to bring the desired 1KC modulation frequency to approximately the mid-range position of R451, the vernier front panel control.

MOD FREQ LIMIT (R452)

Preset MOD FREQ VERNIER (R451) on the front panel to mid-range and the RF FUNCTION Switch to MOD CW.

Connect the vertical input of the oscilloscope to J601-13.

Adjust R452 for exactly 20 cycles on the scope.

60-CYCLE GENERATOR
(Used with Mechanical Sweep Drive Only)

The BLANKING PHASE Control in the plug-in ("E" or "S" Models) and C413 form an AC voltage divider and phase shifting network. The phase of the signal fed to the grid of V404A is determined by the setting of the BLANKING PHASE Control. This setting is covered in the manuals for the individual plug-ins.

The bias on V404A is set by adjusting R442, BLANKING WIDTH. The proper bias provides approximately equal periods for the negative and positive portions of the squared output.

BLANKING WIDTH (R442)

An "E" or "S" model plug-in oscillator must be used in adjusting this control.

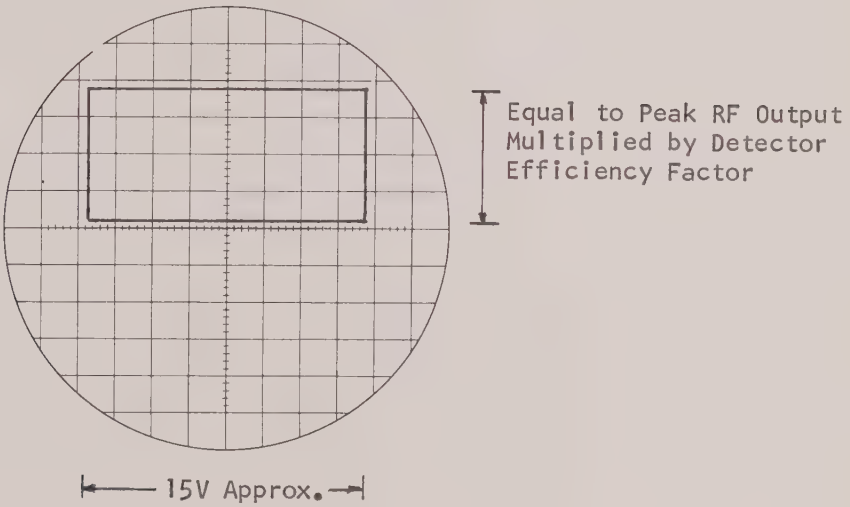
Preset the following controls:

RF FUNCTION to SWEEP

LEVEL Control fully clockwise

Attenuators both in 0 db position.

Connect the RF 1 (or RF 2) output through an RF detector to the vertical input of the scope. A rectangular pattern should appear.

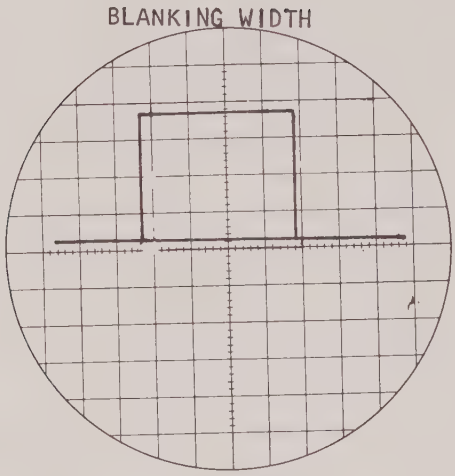


Adjust SCOPE VERTICAL and HORIZONTAL SENSITIVITY Controls to present a pattern as shown. Pattern will deflect up or down depending on output polarity of the RF Detector. Patterns shown are with Telonic half-wave detector having a negative output. A vertical line indicates no horizontal output. First check scope and connecting cables, then trouble shoot horizontal sweep section.

A horizontal line with zero amplitude indicates no RF output. First check scope, RF Detector and connecting cables. Then trouble shoot as prescribed in MAINTENANCE, Section V.

A horizontal line deflected below zero indicates no blanking. Trouble shoot the blanking generator.

If pattern is not rectangular, adjust BLANKING WIDTH.



MARKER CIRCUIT

MARKER SIZE (R503 through R511)

These controls set the amplitude of the individual marker signals at the input to the birdy-by-pass amplifier system. They are set for optimum viewing of each marker. Perhaps the most common adjustment procedure would be that which results in equal amplitude for all markers, but these controls allow for emphasis and de-emphasis of individual markers.

SECTION V
MAINTENANCE

GENERAL

Maintenance of any electronic equipment requires the application of common rules of trouble-shooting, such as checking for charred resistors, component damage, open filaments, and glowing anodes. Further procedures are presented below with the assumption that these checks have been made.

In addition to these rules, the schematic section of this manual simplifies trouble-shooting with a refinement which provides a quick tie-in of the block diagram with the schematic.

The block diagram of the SM-2000, divided into "compartments" representing each of the five schematic diagrams, leads off the schematic section. At the right side of each compartment is shown the numbers of the pins (on the 32-contact jack and plug which inter-connect the control chassis and the plug-in unit) which are associated with each function in that compartment.

A recommended maintenance procedure taking advantage of this layout, with a sample malfunction, follows:

1. Determine the apparent source of the trouble from the nature of the malfunction. For example, no 1KC modulation in the MOD modes would indicate possible failure of the 1KC generator, particularly if blanking is still present in the SWEEP modes.

2. Locate the functional block concerned on the block diagram. The 1KC generator is seen to be in the compartment representing schematic number 3.

3. Fold out the schematic for the compartment containing the block.

4. Locate the circuitry for the particular function on the schematic diagram. The 1KC generator is seen to be near the lower left corner of schematic number 3.

5. Check the circuit components to locate the trouble. If V405 is found to be defective, the sample trouble probably has been located.

TROUBLE SHOOTING CHARTS

The expansion of the above procedure to the use of the contacts on J601 and P601 as check points is obvious. For example, if all markers disappear from the trace, but a "birdy" is found at Pin 17 (with oscillators containing a variable marker), the trouble almost certainly is in the marker amplifier systems, schematic number 5 if the jumper from Pins 9 and 10 to Pin 11 of P601 is intact

This criterion can be applied in many instances in deciding whether a trouble lies in the control chassis or the head. The following chart is offered as an aid in such decisions. It is assumed that a visual check indicates that all jumpers are intact.

SYMPTOM	CHECK (ON J601)
Weak or no output or unleveled output	DC voltage at Pin 31 with RF LEVEL fully clockwise
RF 2 output not leveled ("E" Models only)	RF 1 output
No sweep width	With "L" Models: 1. Voltage across R473 2. Resistance between Pins 14 and 15, 28 and 29, 30 and 4.
	With "E" and "S" Models: Resistance between Pins 27 and 9, 26 and 27, 26 and ground.
Changing sweep width changes center frequency	With "L" Models: Resistance between Pins 29 and 5, 28 and 5, 29 and ground.
	With "E" and "S" Models, the frequency range above and below the dial setting normally will be unequal except at narrow sweep widths. With oscillators which are current-tuned, a change in center frequency with a change in sweep width is normal.
No variable marker (Plug-in marker present)	1. For birdy at Pin 17
	2. DC voltage at Pin 1

IF RESULT IS	TROUBLE PROBABLY IN	
	PLUG-IN	SM-2000
High (see values in oscillator manual)	X	
Low or zero		X
NOTE: Trouble probably in plug-in if output not level with "LA" series.		
Leveled RF 1 output	X	
RF 1 output not level		X
Sawtooth or triangular waveform	X	
OV or DC voltage	Inconclusive. See check #2	
Open on any check	X	
Continuity		X
Open between		
27 and 9	X	
26 and 27		X
26 and ground	X	
Open on any check	X	
Continuity		X
Birdy present		X
No birdy	Inconclusive. See check #2	
100 V	X	
Low or no voltage		X

The following chart is prepared to assist in locating those troubles which the previous chart indicates may be in the control chassis:

SYMPTOM	CHECK
Weak or no output	Supply voltages (if low check power supply circuit beginning with V102). See block diagram for J601 pin numbers at which the voltages can be checked. Check leveler circuit. Check V304, V404B and associated circuitry.
Unleveled output	Monitor diode (CR202); V301-V303 and associated circuits.
No sweep width	With "L" Models: Horizontal deflection voltage at J601-21. If present, check V301C, V402C, V406, and associated circuitry. If not, calibrate vari-rate circuit(see Section IV). If this circuit cannot be calibrated, trouble-shoot the vari-rate circuit. See General Description, Section III. With "E" and "S" Models: If open between Pins 26 and 27, check R471 and S403-2B. If not, look for trouble in "B" phase filament circuit.
Changing sweep width also changes center frequency	With "L" Models: Recheck calibration of R469 and R463. Check V402 and associated components.
No variable marker	If plug-in markers are present, check monitor-marker mixer box and leads (particularly CR201). If no plug-in markers are present, check V504 and associated circuits.

Additional troubles which probably are due to malfunctions in the chassis include:

SYMPTOM	CHECK
No blanking, or incomplete blanking (1KC modulation normal) blanking on CW modes.	V404 and associated circuitry. S403-1C.
No 1KC modulation; less than 100% modulation; 1KC modulation in SWEEP and CW modes (normal blanking).	Check V303, V304, V404, and associated circuits. components. Check S403-1B. Recalibrate R452.
No 1KC modulation and no blanking	CR301 for short or reversed polarity. V303, V304, and associated circuitry.

SYMPTOM	CHECK
Sweep rate wrong	Vari-rate circuit. Recalibrate R416, R421, R423, R424 (See Section IV). Check S401.
Blanking phase and/or width wrong	Recalibrate R442. Check V404A and associated circuitry.
Insufficient sweep width	V402, V406 and associated circuitry.
Some, but not all, markers missing	Check V501, V502, or V503 as appropriate. Check S501-508.
Excessive or no horizontal deflection voltage ("L" Models), normal sweep width	R429, R430 NOTE: With normal filament voltage, and with leads intact, this trouble with "E" and "S" models probably is in the plug-in rather than the control chassis. See Maintenance Section of the manual for the oscillator.

MONITOR DIODE REMOVAL

One of the most frequent troubles in the SM-2000 is monitor diode failure. To replace the monitor diode, remove the four screws holding the filter in place and remove the filter. If the diode does not extract with the filter, it may be removed easily with long-nosed pliers. It is not necessary to open the monitor block to change the monitor diode.

Be sure to insert replacement with polarity as indicated on Schematic #4. The arrow should point inward.

See page 4-1 for location of filter.

PART VALUE INFORMATION

SCHEMATIC PART DESIGNATION

C	Capacitor
CR	Crystal Rectifier, Germanium Diode
F	Fuse
I	Incandescent Pilot Light
J	Jack or termination
L	Inductor
M	Meter or Motor
P	Plug
R	Resistor, Fixed or Variable
S	Switch
T	Transformer
V	Electron tube
Z	Miscellaneous

SCHEMATIC VALUE ABBREVIATION

Ω	ohms
k	1,000 ohms
M	1,000,000 ohms (megohms)
µf, uf	Microfarad
pf	Picofarad
µh, uh	Microhenry
mh	Millihenry

RESISTORS - All resistors are 1/2 watt, ± 10%, and are shown in ohms, unless otherwise specified.

NOTE: Resistors in the attenuator pads are ± 1%.

CAPACITORS - All capacitors are shown in picofarads (pf) unless otherwise specified.

INDUCTORS - All inductors are shown in microhenries (µh) unless otherwise specified.

PARTS LOCATION - F.P. Front Panel
R.P. Rear Panel
T.P. Test Point

PARTS NUMBERS - LOCATION INFORMATION

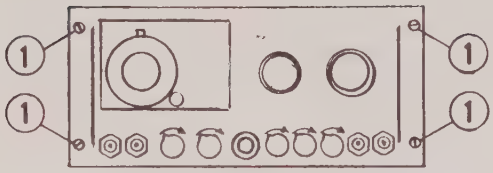
101 - 199 - Power Supply
201 - 299 - Monitor, Mixer, Attenuators
301 - 399 - Leveler
401 - 499 - Horizontal and Sweep Drive Circuit
501 - 599 - Plug-in Markers and Marker Amplifier
601 - 699 - Interconnections between Control Chassis and Oscillator

* Indicates value of component adjusted at factory, and may deviate from value shown on print.

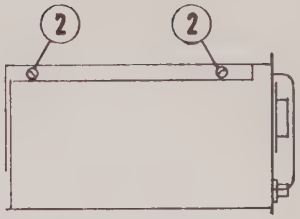
N O T I C E

RED LACQUER IS USED TO INDICATE FASTENINGS THAT SHOULD NOT BE DISTURBED FOR ORDINARY SERVICE, AND TO SECURE ADJUSTABLE CONTROLS.

RACK MOUNTED UNIT



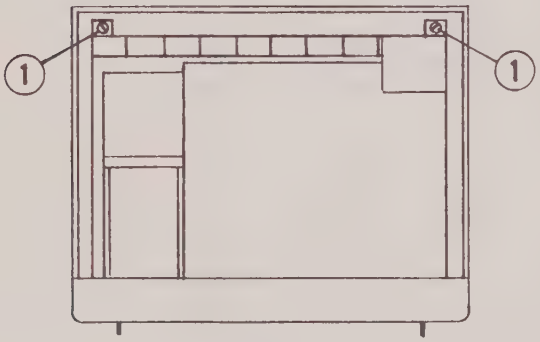
FRONT



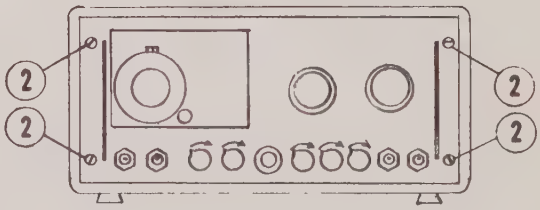
SIDE

Unit has front panel slotted or drilled for standard RTMA Mounting. Position unit in rack and install mounting screws in holes marked (1).
Dust cover removal: Remove four #8-32 thread-cutting screws, marked (2) (two on each side) and lift off cover for easy access to chassis.

CABINET MOUNTED UNIT



TOP



FRONT

To remove chassis from cabinet; first remove the two #8-32 screws (marked (1) on top view above) at the back of the chassis (one on each side). These screws fasten the chassis to the cabinet guide rails. Second, remove the four #10-32 screws (marked (2) in front view above). The screws hold the panel to the cabinet.

Slide chassis out of cabinet by pulling forward on the two front panel handles.

To replace chassis in cabinet, insert the flanges on the bottom of the chassis side panels into the slot of the cabinet guide rails. Push chassis back into cabinet far enough for the slots in the side panel flanges to align with the retained nut in guide rail. Install the two #8-32 screws and tighten securely. Replace the four #10-32 screws in the front panel.

SECTION VI

PARTS LIST

CIRCUIT REFERENCE	DESCRIPTION	TELONIC PART NUMBER
C101	CFE, 80/10/10 µf, 450 VDCW	C-323
C102	CFP, 0.22 µf, ± 20%, 400 VDCW	C-217
C103	Same as C102	
C104	CFE, 50 µf, 450 VDCW	C-327
C105	CFP, 0.1 µf, ± 10%, 400 VDCW	C-211
C106	CFP, 0.1 µf, ± 10%, 200 VDCW	C-203
C201	CFCF, 1000 pf, ± 20%, 500 VDCW	C-39
C202	CFC, 200 pf, ± 20%, 1000 VDCW	C-16
C203	CFM, button, 500 pf, ± 20%, 500 VDCW	C-86
C204	CFM, button, 300 pf, ± 20%, 500 VDCW	C-87
C205	CFC, 5000 pf, ± 10%, 600 VDCW	C-49
C301	CFC, 50 pf, ± 10%, 1000 VDCW	C-11
C302	Same as C301	
C401	Same as C301	
C402	CFMY, 2.2 µf, ± 5%, 200 VDCW	C-90
C403	CFMY, 0.22 µf, ± 10%, 200 VDCW	C-79
C404	CFMY, 0.022 µf, ± 10%, 200 VDCW	C-80
C405	CFMY, 0.0022 µf, ± 10%, 200 VDCW	C-81
C406	CFM, 200 pf, ± 10%, 500 VDCW	C-91
C407	Same as C406	
C408	CFMY, 0.004 µf, ± 10%, 600 VDCW	C-84
C409	CFMY, 0.04 µf, ± 10%, 400 VDCW	C-83
C410	CFMY, 0.2 µf, ± 10%, 200 VDCW	C-82
C411	Same as C410	
C412	CFM, 0.0033 pf, ± 10%, 500 VDCW	C-52
C413	CFP, 0.22µf, ±20%, 400VDCW ICW	C-217
C414	Same as C105	
C415	Same as C105	
C416	CFC, 120 pf, ± 10%, 1000 VDCW	C-14
C451	CFM, 2200 pf, ± 10%, 500 VDCW	C-24
C452	Same as C451	
C453	Same as C104	
C454	CFC, 0.02 µf, +80-20%, 500 VDCW	C-21
C501	CFC, 1000 pf, GMV, 500 VDCW	C-19
C502	CFC, 0.01 µf, +80-20%, 500 VDCW	C-20
C503	CFC, 0.005 µf, ± 20%, 600 VDCW	C-73
C504	Same as C503	
C505	Same as C503	
C506	Same as C503	
C507	Same as C501	
C508	CFC, 470 pf, GMV, 1000 VDCW	C-18
C509	Same as C508	
C510	Same as C501	
C511	Same as C503	
C512	Same as C416	
C513	Same as C501	
C514	Same as C501	
C515	Same as C502	
C516	Same as C202	
C517	Same as C502	
CR101	DSD, 1N2094	D-7
CR102	Same as CR101	
CR103	Same as CR101	
CR104	Same as CR101	
CR201	DSD, 1N82	D-1
CR202	DSD, 1N415B	D-10
CR301	Same as CR101	
CR401	Same as CR101	
CR402	Same as CR101	
CR403	Same as CR101	
CR404	Same as CR101	
CR405	Same as CR101	
CR501	DSD, 1N34A	D-2
F101	3a for 115v 1.5a for 230v	MP-165 MP-166
I101	LI, #47, 6-8v	MP-5
I401	LI, NE-2	MP-135
I402	Same as I401	
J201	TC, MX1684/U	J-9
J202	Same as J201	
J203	Same as J201	
J204	Same as J201	
J205	RJ, BNC Dage type 2545-1	J-10
J206	Same as J205	
J207	PO Z202	
J208	PO Z202	
J209	PO Z201	
J210	PO Z201	
J211	JC, BNC Dage type 2559-1	J-11
J212	Same as J211	
P207	PC, BNC, UG-88B/U	J-32
P208	Same as P207	
P209	Same as P207	
P210	Same as P207	
J501	ARTJ, BNC	J-23
J502	Same as J501	
J503	Same as J205	
J504	Same as J205	
P501	Same as P207	
P502	Same as P207	
J601	Socket, 32 contact	S-38
L501	IF, 10 mh	L-110
L502	Same as L501	
R101	RFC, 120KΩ, ± 10%, 2W	R-315
R102	RFC, 20KΩ, ± 10%, 2W	R-319
R103	RFC, 1MΩ, ± 10%, 1/2W	R-31
R104	RFC, 100Ω, ± 10%, 1/2W	R-15
R105	RFC, 33KΩ, ± 10%, 2W	R-314
R106	RFC, 100Ω, ± 10%, 1W	R-219
R107	Same as R104	
R108	RFC, 33Ω, ± 10%, 1/2W	R-12
R109	RFC, 180KΩ, ± 5%, 1W	R-211
R110	RVC, 15KΩ, 0.2W	R-739
R111	RFC, 82KΩ, ± 5%, 1/2W	R-100
R112	RFC, 180KΩ, ± 10%, 2W	R-316
R113	Same as R105	
R114	Same as R103	
R115	Same as R104	
R116	RFC, 27KΩ, ± 10%, 2W	R-304
R117	Same as R106	
R118	Same as R104	
R119	Same as R108	
R120	RFC, 100KΩ, ± 5%, 1W	R-218
R121	Same as R110	
R122	Same as R111	
R123	RFC, 4.7Ω, ± 10%, 1W	R-206
R124	RFW, 500Ω, 10W	R-506
R125	RFW, 5KΩ, 10W	R-507
R126	RFC, 15KΩ, ± 10%, 1/2W	R-66
R127	RFC, 100KΩ, ± 10%, 1/2W	R-28
R128	Same as R123	
R201	RFC, 220Ω, ± 10%, 1/2W	R-39
R202	RFC, 56Ω, ± 10%, 1/2W	R-13
R203	Same as R202	
R204	Same as R202	
R205	RFC, 1.2KΩ, ±10%, 1/2W	R-92
R206	RFC, 470Ω, ±10%, 1/2W	R-42
R207	Same as R206	
R208	RFC, 51Ω, ± 5%, 1/2W	R-3
R209	Same as R201	
R301	RFC, 560KΩ, ± 10%, 1/2W	R-29
R302	RFC, 470KΩ, ± 10%, 1/2W	R-73
R303	RVC, 25KΩ, 0.2W	R-750
R304	PO S301	
R305	Same as R303	
R306	RFC, 10KΩ, ± 10%, 1/2W	R-23
R307	Same as R127	
R308	Same as R103	
R309	RFC, 39KΩ, ± 10%, 1/2W	R-26
R310	RFC, 180KΩ, ± 10%, 1/2W	R-45
R311	Same as R306	
R312	Same as R302	
R313	Same as R104	
R314	Same as R104	
R401	RVC, 500KΩ, 0.2W	R-734
R402	Same as R310	
R403	RFC, 330KΩ, ± 10%, 1/2W	R-94
R404	RVC, 100KΩ, 0.2W	R-732
R405	RFC, 220KΩ, ± 10%, 1/2W	R-44
R406	Same as R310	
R407	Same as R127	
R408	Same as R405	
R409	Same as R127	
R410	Same as R403	
R411	Same as R309	
R412	Same as R103	
R413	RFC, 680KΩ, ± 10%, 1/2W	R-30
R414	Same as R413	
R415	RFC, 1.5MΩ, ± 10%, 1/2W	R-32
R416	RVC, 200KΩ, 0.2W	R-724
R417	Same as R403	
R418	Same as R403	
R419	Same as R302	
R420	RFC, 820KΩ, ± 10%, 1/2W	R-95
R421	PO S401	
R422	RVC, 7.5MΩ, 0.3W	R-748
R423	Same as R416	
R424	RVC, 50KΩ, 0.2W	R-725
R425	RFC, 33KΩ, ± 10%, 1/2W	R-36
R426	RFC, 270KΩ, ± 10%, 1/2W	R-62
R427	RFCF, 100KΩ, ± 1%, 1/2W	R-868
R428	RFCF, 221KΩ, ± 1%, 1/2W	R-869
R429	Same as R420	
R430	Same as R403	
R431	RFC, 1.8MΩ, ± 10%, 1/2W	R-33
R432	Same as R310	
R433	Same as R425	
R434	RFC, 27KΩ, ± 10%, 1/2W	R-25
R435	Same as R434	
R436	RFC, 12KΩ, ± 5%, 1/2W	R-120
R437	RFC, 22KΩ, ± 5%, 1/2W	R-105
R438	RFC, 3.3KΩ, ± 5%, 1/2W	R-121
R439	PO S401	
R440	Same as R103	
R441	Same as R431	
R442	RVC, 10KΩ, 0.3W	R-740
R443	Same as R127	
R444	Same as R103	
R445	Same as R103	
R446	NA	
R447	NA	
R448	Same as R405	
R451	PO S403	
R452	Same as R404	
R453	Same as R302	
R454	Same as R413	
R455	Same as R302	
R456	Same as R413	
R457	RFC, 1KΩ, ± 10%, 1/2W	R-18
R458	Same as R405	
R459	RFC, 270KΩ, ± 10%, 1/2W	R-62
R460	Same as R459	
R461	RFC, 390KΩ, ± 10%, 1/2W	R-72
R462	Same as R425	
R463	Same as R401	
R464	RFCF, 2.32MΩ, ± 1%, 1/2W	R-871
R465	RFCF, 1.3MΩ, ± 1%, 1/2W	R-870
R466	Same as R302	
R467	PO R471 Assembly	
R468	Same as R405	
R469	Same as R416	
R470	Same as R464	
R471	RDWW/C, 6Ω, 2W; 1MΩ, 1/3W	R-745
R472	RFC, 2.7MΩ, ± 10%, 1/2W	R-41
R473	RFCF, 470Ω, ± 5%, 2W	R-317
R474	Same as R457	
R475	Same as R104	
R476	RFC, 270KΩ, ± 5%, 1/2W	R124
R477	RFC, 110KΩ, ± 5%, 1/2W	R-117
R478	RFC, 470KΩ, ±5%, 1/2W	R-125
R501	PO J501	
R502	PO J502	
R503	Same as R442	
R504	Same as R442	
R505	Same as R442	
R506	Same as R442	
R507	Same as R442	
R508	Same as R442	
R509	Same as R442	
R510	Same as R442	
R511	PO S509	
R512	RFC, 10KΩ, ± 10%, 1W	R-213
R513	RFC, 47KΩ, ± 10%, 1/2W	R-27
R514	Same as R513	
R515	Same as R104	
R516	Same as R306	
R517	Same as R306	
R518	Same as R306	
R519	RFC, 22KΩ, ± 10%, 1/2W	R-24
R520	Same as R519	
R521	Same as R519	
R522	Same as R127	
R523	RFC, 6.8KΩ, ± 10%, 1/2W	R-109
R524	RFC, 3.9KΩ, ± 5%, 1/2W	R-122
R525	RFC, 3.3KΩ, ± 5%, 1/2W	R-70
R526	Same as R513	
R527	Same as R104	
R528	Same as R306	
R529	Same as R513	
R530	Same as R306	
R531	RFC, 470Ω, ± 10%, 1/2W	R-42
R532	PO S510	
R533	PO S510	
R534	Same as R513	
S101	SWT, SPST	SW-38
S102	SWT, DPDT	SW-3
S301	ASW, SP 3 pos, w/50KΩ, RVC	SW-15
S401	ASW, 6 wafers, 1 pole, 7 pos, w/ 10MΩ RVC and 200KΩ, RVC	SW-17
S402	ASW, 1 wafer, 3 pole, 2 pos	SW-19
S403	ASW, 2 wafer, 3 pole, 4 pos, w/10KΩ RVC	SW-16

PARTS LIST

CIRCUIT REFERENCE	DESCRIPTION	TELONIC PART NUMBER
S501	Same as S101	
S502	Same as S101	
S503	Same as S101	
S504	Same as S101	
S505	Same as S101	
S506	Same as S101	
S507	Same as S101	
S508	Same as S101	
S509	ASW, SPST, w/10KΩ RVC	R-749
S510	ASW, 4 wafers, 1 pole, 8 pos, w/100K-100KΩ RVC	SW-18
T101	TP	T-14
V101	TE, 0A2	VT-21
V102	TE, 5651	VT-17
V103	TE, 6J11	VT-33
V104	TE, EL34	VT-31
V105	Same as V104	
V301	TE, 6C10	VT-23
V302	TE, 6AU6	VT-5
V303	Same as V302	
V304	TE, EL84/6BQ5	VT-16

CIRCUIT REFERENCE	DESCRIPTION	TELONIC PART NUMBER
V401	TE, 6D10	VT-27
V402	Same as V401	
V403	Same as V302	
V404	TE, 6CM8	VT-24
V405	Same as V404	
V406	Same as V304	
V501	Same as V301	
V502	Same as V301	
V503	Same as V301	
V504	Same as V301	
Z201	50Ω Attenuator, 50 db in 10 db steps	05011
Z202	50Ω Attenuator, 10 db in 1 db steps	05010
Z501	Socket, wafer	S-11
Z502	Same as Z501	
Z503	Same as Z501	
Z504	Same as Z501	
Z505	Same as Z501	
Z506	Same as Z501	
Z507	Same as Z501	
Z508	Same as Z501	

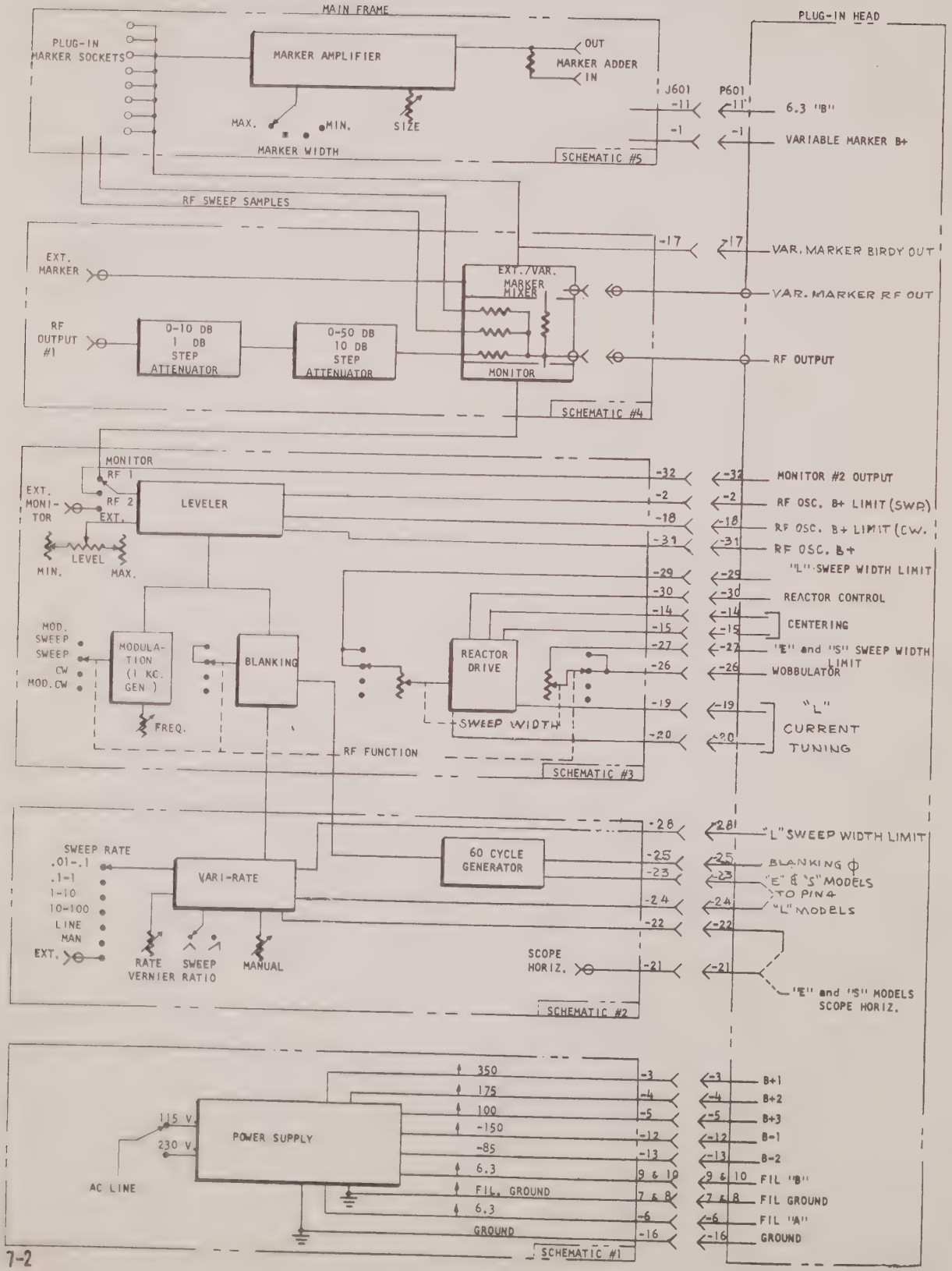
ABBREVIATION CODE

ARTJ	Assembly, Resistive Terminator Jack
ASW	Assembly, Switch
CFC	Capacitor, fixed, ceramic
CFCF	Capacitor, fixed, ceramic feed-thru
CFE	Capacitor, fixed, electrolytic
CFM	Capacitor, fixed, mica
CFMB	Capacitor, fixed, mica, button type
CFMY	Capacitor, fixed, mylar
CFP	Capacitor, fixed, paper
DSD	Device, semi-conductor, diode
IF	Inductor, fixed
JC	Jack, cable
LI	Lamp, Incandescent
NA	Not assigned
PC	Plug, cable
PO	Part of
RDFW	Resistor, dual, fixed, wirewound
RDVW	Resistor, dual, variable, wirewound
RDVW/C	Resistor, dual, variable, wirewound/composition
RFC	Resistor, fixed, composition
RFCF	Resistor, fixed, composition, film type
RJ	Receptacle, Jack
RVC	Resistor, variable, composition
SWT	Switch, toggle
TC	Terminator, cable
TE	Tube, electron

SECTION VII

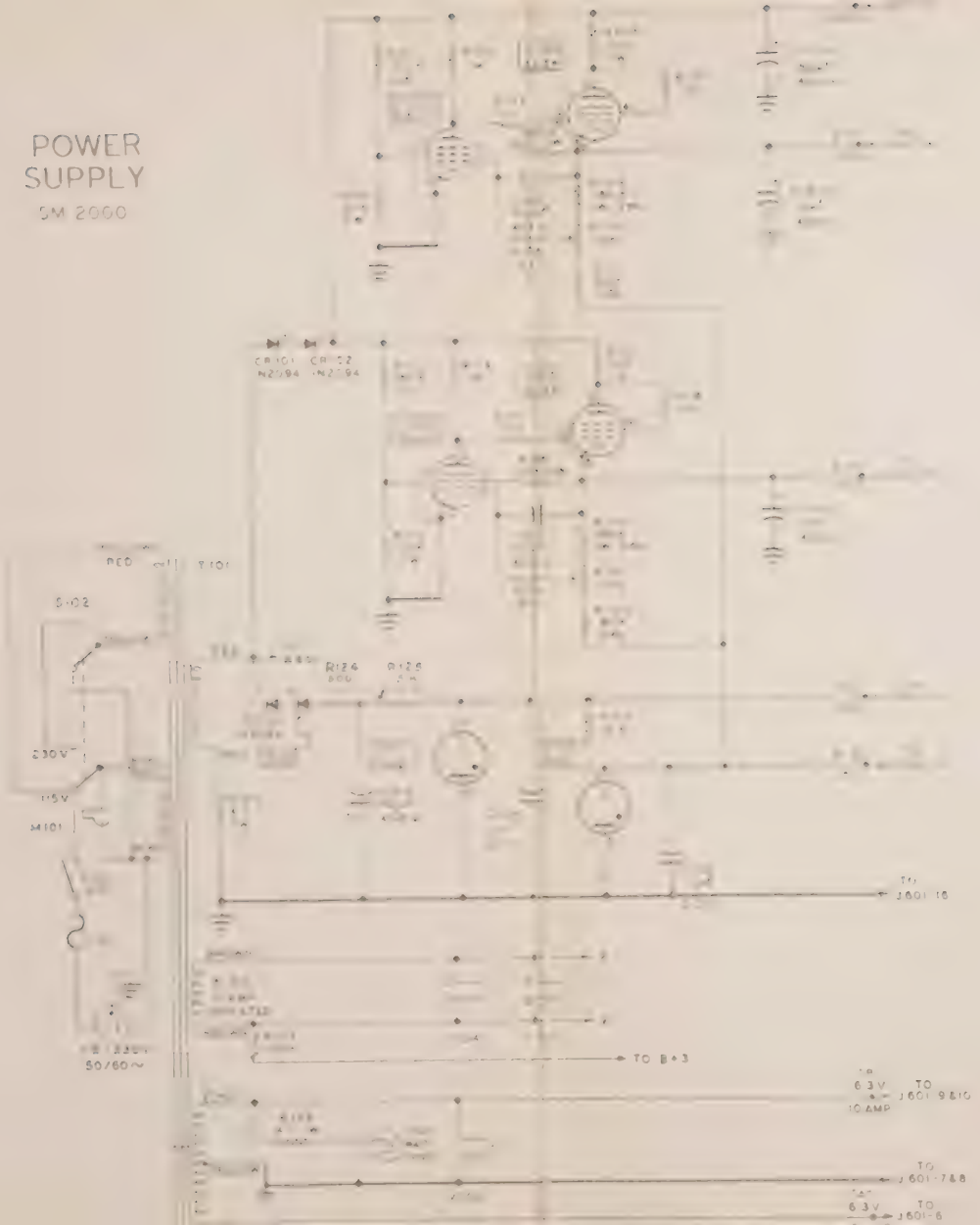
SCHEMATIC DIAGRAMS

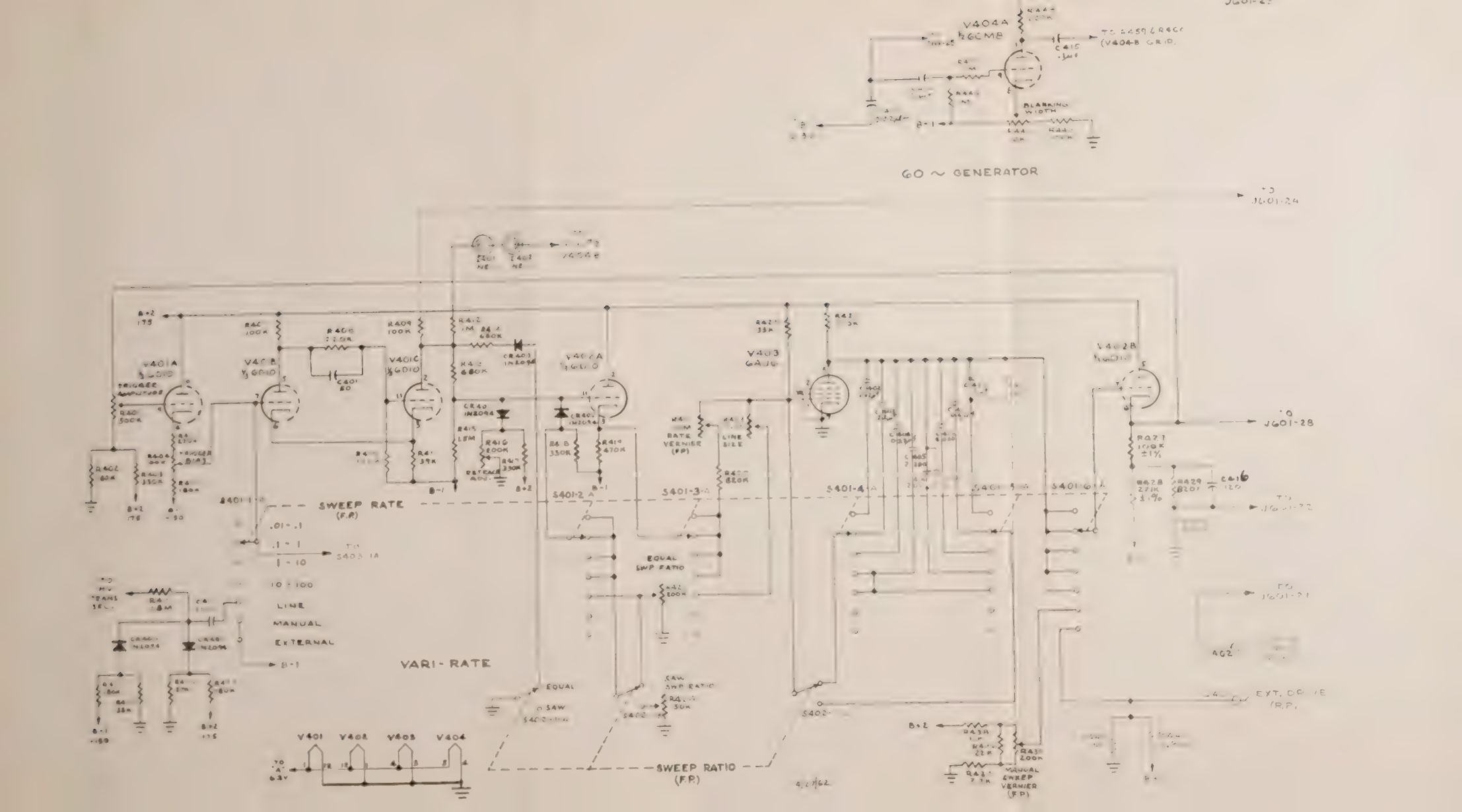
BLOCK DIAGRAM

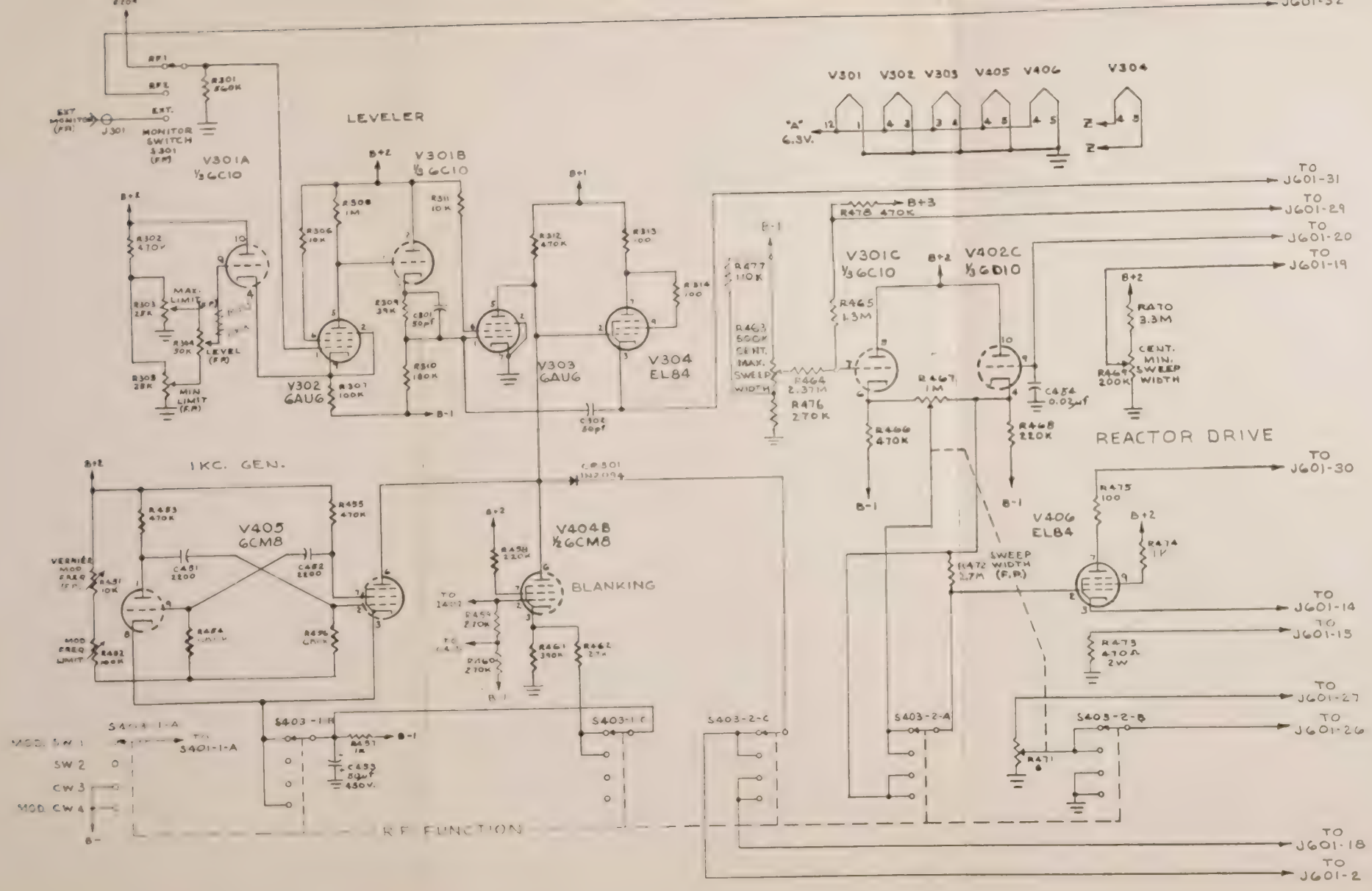


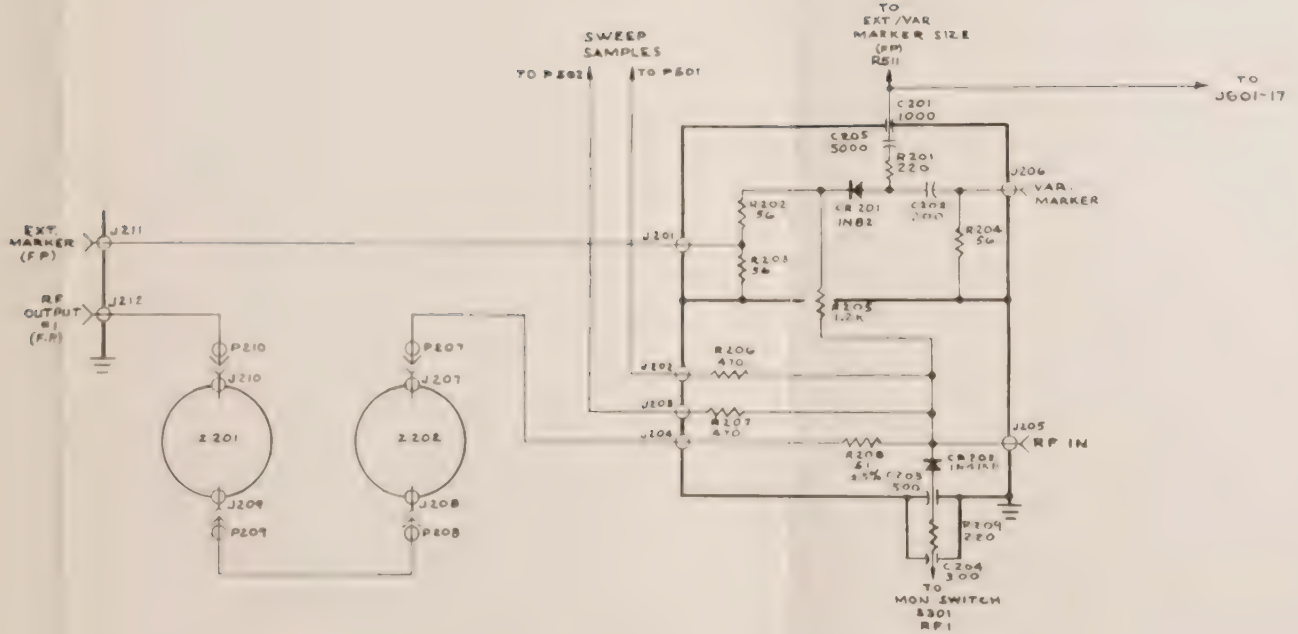
POWER SUPPLY

SM 2000




V404A
½6CM8
BLANKING WIDTH
60 ~ GENERATOR
V401A
½6D10
TRIGGER AMPLITUDE
V401B
½6D10
V401C
½6D10
V402A
½6D10
V403
6AU6
V402B
½6D10
TRIGGER BIAS
SWEEP RATE
(F.P.)
.01 - .1
.1 - 1
1 - 10
10 - 100
LINE
MANUAL
EXTERNAL
VARI-RATE
RATE VERNIER (F.P.)
LINE SIZE
EQUAL SWP RATIO
SAW SWP RATIO
EQUAL
SAW
SWEEP RATIO
(F.P.)
MANUAL SWEEP VERNIER (F.P.)
EXT. DRIVE (R.P.)
V401
V402
V403
V404
S401-1A
S401-2A
S401-3A
S401-4A
S401-5A
S401-6A
S402
S403-1A
J601-24
J601-28
J601-22
J601-21
A02
4/27/62

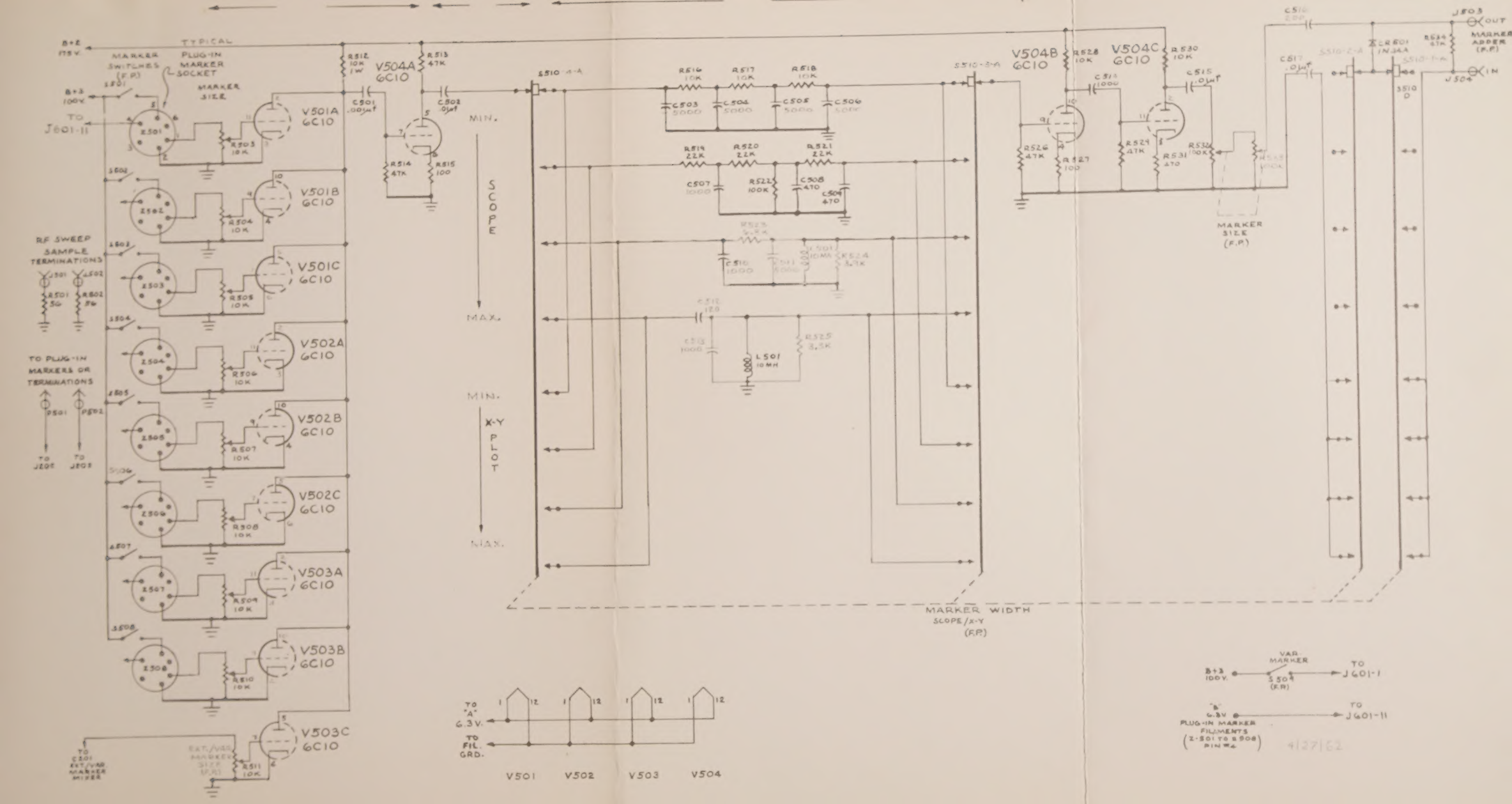

V301 V302 V303 V405 V406
V304
"A" 6.3V.
LEVELER
V301A ½6C10
V301B ½6C10
V302 6AU6
V303 6AU6
V304 EL84
V301C ½6C10
V402C ½6D10
V406 EL84
V405 6CM8
V404B ½6CM8
1KC. GEN.
BLANKING
REACTOR DRIVE
RF FUNCTION
EXT MONITOR (FM)
EXT.
MONITOR SWITCH S301 (FM)
J301
MAX. LIMIT (F.M.)
LEVEL (F.M.)
MIN. LIMIT (F.M.)
VERNIER MOD FREQ (F.M.)
MOD FREQ LIMIT
SWEEP WIDTH (F.P.)
CENT. MIN. SWEEP WIDTH
MOD. SW 1
SW 2
CW 3
MOD CW 4
B+1
B+2
B+3
B-1
B-
TO J601-31
TO J601-29
TO J601-20
TO J601-19
TO J601-30
TO J601-14
TO J601-15
TO J601-27
TO J601-26
TO J601-18
TO J601-2



0 - 10 db
1 db
STEP
ATTENUATOR

0 - 50 db
10 db
STEP
ATTENUATOR

EXT./VAR. MARKER MIXER
& MONITOR
4/27/62


B+E 175V.
TYPICAL PLUG-IN MARKER SOCKET
MARKER SWITCHES (F.P.)
MARKER SIZE
B+3 100V.
TO J601-11
S501
S502
S503
S504
S505
S506
S507
S508
V501A 6C10
V501B 6C10
V501C 6C10
V502A 6C10
V502B 6C10
V502C 6C10
V503A 6C10
V503B 6C10
V503C 6C10
R512 10K 1W
R513 47K
V504A 6C10
C501 .005μf
C502 .05μf
R514 47K
R515 100
RF SWEEP SAMPLE TERMINATIONS
J501
J502
R501 50
R502 50
TO PLUG-IN MARKERS OR TERMINATIONS
P501
P502
TO J602
TO J603
TO C501 EXT/VAR MARKER MIXER
EXT/VAR MARKER SIZE (F.P.)
R511 10K
SCOPE
MIN.
MAX.
X-Y PLOT
MIN.
MAX.
S510-4-A
R516 10K
R517 10K
R518 10K
C503 5000
C504 5000
C505 5000
C506 500
R519 22K
R520 22K
R521 22K
C507 5000
R522 100K
C508 470
C509 470
R523 3.3K
C510 1000
C511 5000
L501 10MH
R524 3.3K
C512 120
C513 1000
R525 3.3K
S510-3-A
V504B 6C10
R528 10K
C514 1000
V504C 6C10
R530 10K
C515 .01μf
R526 47K
R527 100
R529 47K
R531 470
R532 100K
C516 500
C517 .01μf
S510-2-A
S510-1-A
S510 D
CR601 1N34A
R534 47K
J503 OUT
MARKER ADDER (F.P.)
J504 IN
MARKER SIZE (F.P.)
MARKER WIDTH SCOPE/X-Y (F.P.)
TO "A" 6.3V.
TO FIL. GRD.
1
12
V501
V502
V503
V504
VAR. MARKER
S 504 (F.P.)
B+3 100V.
TO J601-1
"A" 6.3V
PLUG-IN MARKER FILAMENTS (J-501 TO J-508 PIN #4)
TO J601-11
4/27/62

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